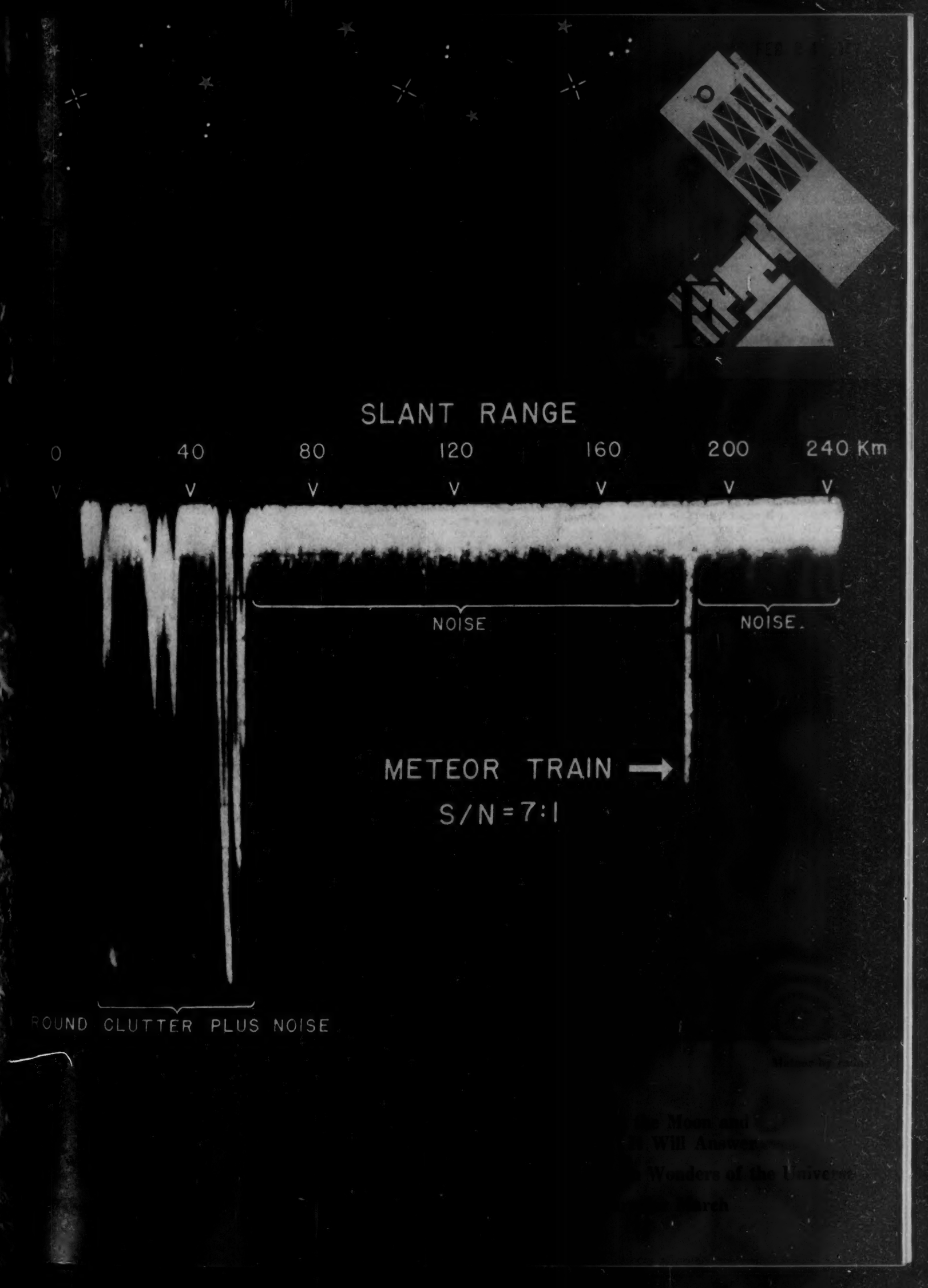

SLANT RANGE
0
40
80
120
160
200
240 Km
V
NOISE
NOISE.
METEOR TRAIN
S/N=7:1
ROUND CLUTTER PLUS NOISE

In Focus

PLATE XII in the series of moon photographs includes one of the famous lunar mountain ranges, the Apennines, and part of Mare Imbrium. All named features are sketched on the accompanying chart, and descriptions of some of these are given. Spellings follow the International Astronomical Union's **Named Lunar Formations,** by Blagg and Mueller, and biographical information is from the British Astronomical Association's **Who's Who in the Moon.**

This chart overlaps Plates V, VI, VII, and XI, and some In Focus items for features on it will therefore be found in the issues of June, July, and August, 1946, and February, 1947.

Apennines. This impressive mountain range on the southwest edge of Mare Imbrium is very interesting to observe at the time of either rising or setting sun. Several of its highest mountains are discussed below, and there are a number of interesting mountain formations and valleys.

Archimedes. This walled plain, about 50 miles in diameter, has rather low walls rising above a smooth interior. The Greek mathematician and physicist, after whom the formation is named, lived in the third century B. C. and discovered, among other things, the hydrostatic principle which bears his name, and the lever principle.

Aristillus. This formation has complex walls, and a central mountain which is not visible at this illumination. Ridges, apparently of lava, Goodacre says, radiate from its outer walls.

Autolycus. This smaller formation is similar to Aristillus, and both were named for early Greek astronomers.

Bode. This crater, about 10 miles in diameter, is named for Johann Elert Bode (1747-1826), director of the Berlin Observatory, and chiefly known today for the planetary "law" which bears his name.

Cape Fresnel. Augustin Jean Fresnel, whose name is given to one of the Apennine features, was a French physicist and student of optics. He made studies of aberration and the polarization of light, and is credited with introducing the use of compound lenses instead of mirrors for lighthouses.

Eratosthenes. Famed for his measurement of the circumference of the earth, Eratosthenes (c. 276-196 B. C.) was an astronomer and geographer, and custodian of the Alexandrian library. On the moon this is a walled plain about 35 miles across, with high walls, one peak of which is said to rise 16,000 feet above the interior. The central mountain, according to Goodacre, "sometimes presents the appearance of a crater ring."

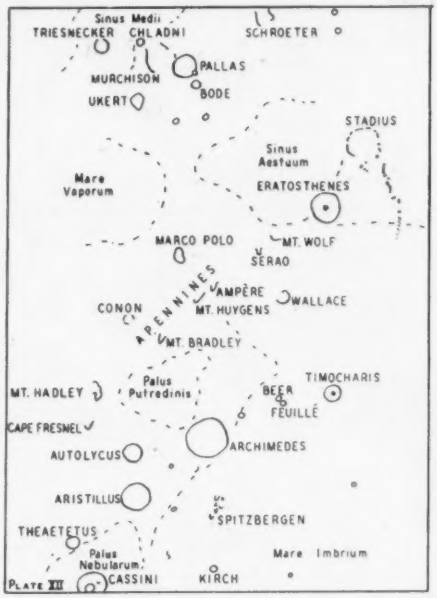
Marco Polo. The famed Venetian traveler, who lived from 1254 to 1324, is represented on the moon by a formation which has also apparently traveled. Its position as given on the maps by Goodacre and others differs considerably from that assigned by the I.A.U. Although the name is Maedler's, the irregularly bordered crater or valley identified on our key chart is that indicated on the Blagg and Mueller maps.

Mare Imbrium. This is the largest lunar sea, named by Riccioli the Sea of Rains, with an area about 340,000 square miles.

Mare Vaporum. The Sea of Vapors, also given its name by Riccioli, appears in part on this chart.

Mount Bradley, Mount Hadley, Mount Huygens, Mount Wolf. Along the length of the Apennines, these four mountains commemorate, respectively, an English astronomer royal; his friend, successful telescope maker; a Dutch astronomer and optician of note; and an 18th-century German philosopher and mathematician. These mountains are respectively 16,000, 15,000, 19,000, and 12,000 feet high. The Wolf mentioned is properly spelled Wolff, the B.A.A. publication notes, the name given to the entire mountain range by Hell, but later Schroeter restored the name of Apennines, originally assigned by Hevelius, and restricted the name Wolff to one of the mountains within the range. **Named Lunar Formations,** the B.A.A. booklet goes on, retains Schroeter's arrangement, but with Maedler's incorrect spelling.

Murchison. Named for a Scottish geologist, this is an example of a ruined plain, with only the wall toward the northwest apparently still more or less in its original state.



(Continued on page 26)

SKY AND TELESCOPE

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MARCH, 1947

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BACK COVER: A portion of the moon near last quarter, from a Lick Observatory photograph taken with the 36-inch refractor by J. H. Moore and J. F. Chappell. This is Plate XII in the series. (See In Focus.)

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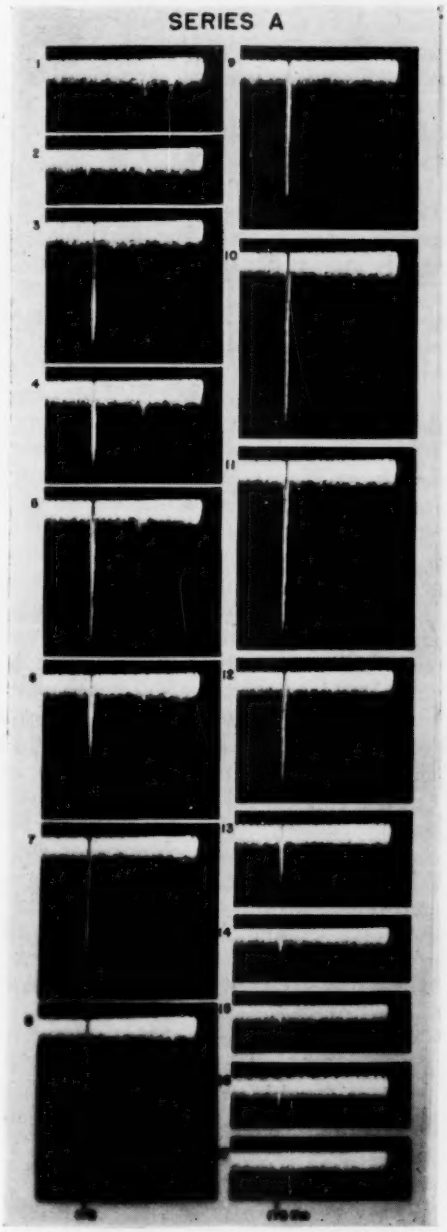
Radar Observations of the Draconids

By John Q. Stewart, *Princeton University Observatory*, and Michael Ference, John J. Slattery, and Harold A. Zahl, *Signal Corps Engineering Laboratories, Bradley Beach, N. J.*

On the night of October 9, 1946, a number of U. S. Army radar equipments were pointed to the sky in an effort to observe any unusual phenomena associated with the meteors expected during the hours when the earth was passing closest to the track of the Giacobini-Zinner comet. The apparatus was operated by civilian and military personnel of the Army Air Forces, Army Ground Forces, and the Signal Corps. The crews were volunteers, engaged in extra work for the purpose of collecting scientific data. Because operating personnel were given only a few hours' notice, no standardized system of observation was set up. The men were highly experienced radar operators but without astronomical background, and they had only meager briefing on what to look for.

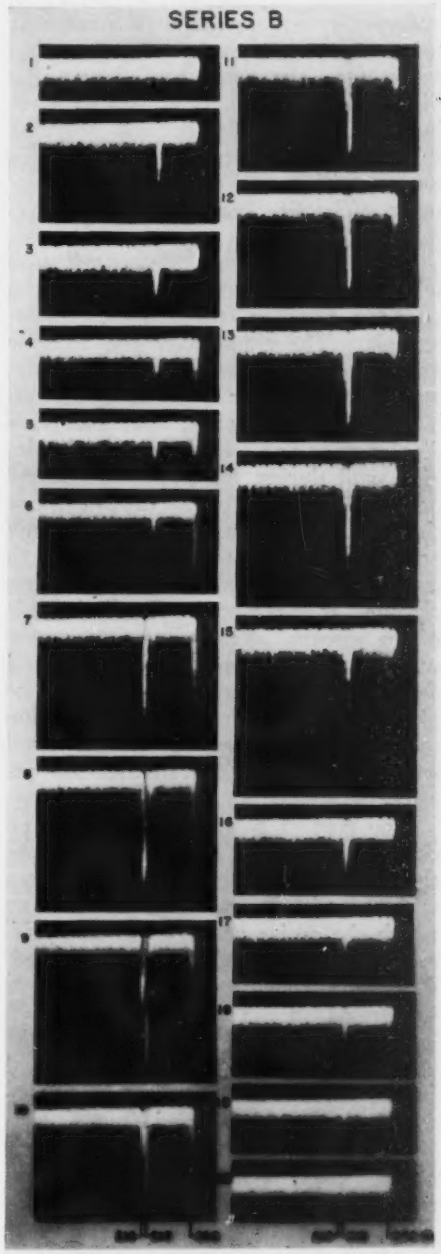


A typical series of photographs, where the echo from a meteor train lasted for several seconds and so appears on a number of consecutive frames. For the sake of emphasis, the ground clutter has been masked off, and the meteor echoes stand out. Series A shows, at one-second intervals, the building and fading of the echo from a train at a slant range of 176 kilometers.

A total of 21 radar equipments of the Army were in operation October 9th between the hours of 2030 and 2300 Eastern standard time, distributed in the vicinities of White Sands Proving Ground, N. M.; Fort Bliss, Tex.; Arco, Ida.; and Belmar, N. J. All apparatus used during the period of observation was in excellent operating condition, because it had been in use for other purposes. Observations were made in the frequency bands of 100, 600, 1,200, 3,000, and 10,000 megacycles.

Significant positive results were found only with the 100-mc. equipment, although it must be stressed that the data are insufficient for a conclusion as to the frequency selectivity of echoes from ionic clouds. In New Jersey, heavy overcast from a Florida hurricane undoubtedly deteriorated the operation of radars of very short wave length. Nearly cloudless skies prevailed in the West, and there were some indications there of positive response in the 3,000-mc. band, but results are uncertain and no photographic record was obtained. On the basis of this night's experiments we cannot conclude that microwave radars do not detect meteor-formed ion clouds. Narrow beams associated with the higher resolving power of microwave radar equipment reduce the probability of meteor echoes. With 600-mc. equipment at Arco, the operators reported that several visible meteors had passed squarely through the radar beam with no accompanying echo. (This observation is compatible with the idea that a radar beam must strike the ionized cylinder of air which forms the meteor train at right angles if a reflection is to take place; see below.) Equipment of 600 megacycles at Belmar gave only negative results through the heavy overcast.

In the 100-mc. band, excellent results were obtained at White Sands with a radar of type SCR-270, and this paper reports these results, originally given at the meeting of the American Astronomical Society on December 29, 1946. In addition to excellent statements from the radar crew, a film record was obtained of the oscilloscope presentation. This is on motion-picture film, at the



Another series showing a consecutive run of photographs, but with echoes from three distinct trains which formed almost simultaneously at ranges of 216, 219, and 250 kilometers, respectively. The relatively great noise in photograph 15 is from electrical interference created briefly by the photographic equipment. All photos by Army Air Forces and Signal Corps.

rate of one frame per second for 23 minutes, giving a total of nearly 1,400 photographs.

A similar radar set operated at Sterling, Va., by personnel of the National Bureau of Standards, also obtained positive results.[1] Radio or radar studies October 9th also succeeded at Massachusetts Institute of Technology, Harvard University, Stanford University, and in London.

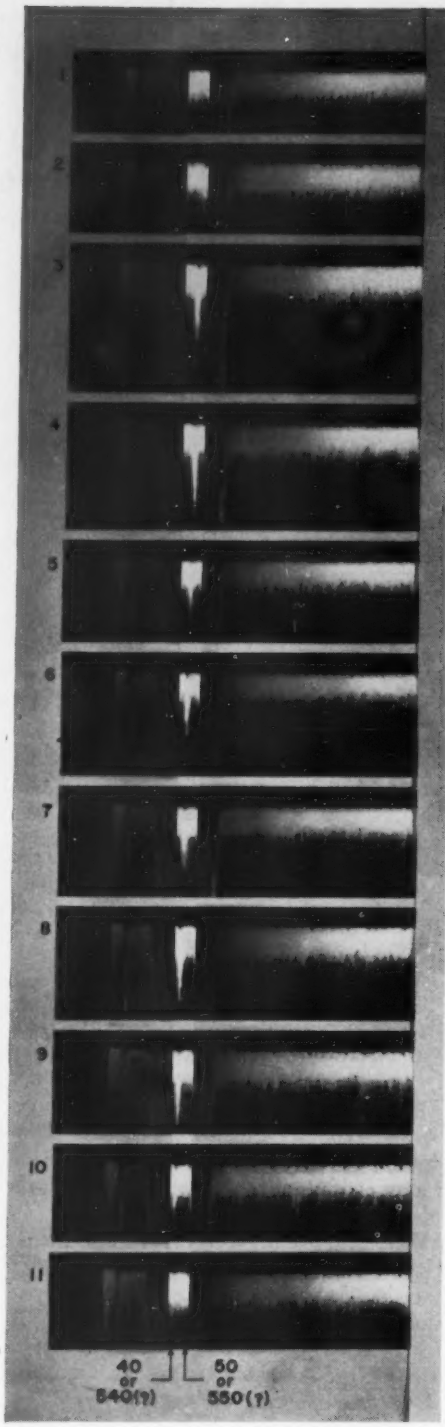
The radar of type SCR-270 has been described at considerable length in various electronic publications. This equipment is an "early warning" type, designed before the war, operating at 106 megacycles. It was with a radar of this type, with some modifications, that echoes from the moon were observed by Signal Corps personnel at Belmar early in 1946. That equipment was provided with a more powerful transmitter, a more sensitive receiver, and a larger antenna. (See *Sky and Telescope,* No. 54, April, 1946.)

In the normal type, transmitted pulse width is variable at the option of the operator between 10 and 30 microseconds. The transmitter and receiver are connected to the same antenna system, with receiver protective devices. The antenna system was eight half-wave dipoles wide and four half-wave dipoles high, and during the tests was pointed north at an angle of 13 degrees above the horizon. However, the resolving power at the three-meter wave length is poor, and responses must have been obtained at directions well off the axis of the antenna. Peak transmitter power was of the order of 50 kilowatts, and the receiver sensitivity was such as to give a saturated signal on the viewing oscilloscope with a received signal strength of 25 microvolts at the receiver terminals.

The type of observation is shown on the front cover. This photograph of the radar oscilloscope screen was taken with a 1/30-second exposure, during which the entire range up to 240 kilometers was scanned 10 times. (Additional range to 500 kilometers was suppressed in the presentation.) Definite radar echoes are shown by the strong signals extending downward from the band of "grass," which is produced by random and meaningless "noise." The signal to noise ratio (S/N) for the meteor train at slant range about 183 kilometers was 7/1. The strong echoes indicated at the left, closer than 60 kilometers, were from hills in the vicinity of the radar station; these lay in general to the northward.

The ground clutter shown in the cover picture was, of course, repeated identically in every frame of the motion-picture film, but the original transmitter pulse, at 0 km., has been suppressed

[1]Bateman, McNish, and Pineo, *Science, 104,* 434, 1946.



In approximately nine seconds, the indicated range of this meteor signal changed from 50 kilometers (frame No. 1) to 40 kilometers (frame No. 11), with the most rapid motion occurring in the early part of the series. The echoes from the hills have been weakened in the print in order to have the moving signal stand out. It is possible that the echo was recorded on the second scanning, and that the range was actually 550 kilometers, decreasing to 540 in this interval.

on this record. The duration of this particular meteor echo was the shortest of any strong signal on the film, less than two seconds, for it does not appear on either the preceding or the following frame. Because of the uncertain directional selectivity at so long a wave length as three meters, the slant range cannot be interpreted in terms of heights above the ground.

The SCR-270 for which the film record was obtained was at Hueco Firing Range, about 25 miles south of White Sands. At Belmar, a general analysis of this film showed 115 strongly distinct indications of separate meteor trains, observed during the 23-minute period near the shower's height, about 2200 EST. Further study of the film by Francis B. Shaffer, a Princeton undergraduate who had radar training in the Navy, increased the total of definite indications to 296. Of the originally determined 115, 18 indications persisted for from three to 27 seconds, while the others lasted only from one to three seconds. The illustrations show typical reflections; very many others were recorded.

It is well known that reflections of this sort are from ionized air in meteor trains, and not from the hypothetical rapidly moving air in the meteor "cap." The meteor itself is far too small to give a reflection. A brief, incomplete analysis of the film indicates that the effective echoing area of meteor trains of appreciable persistence varied between about 50 and 4,000 square meters. When the area was less than 50 square meters, at average ranges, the response was lost in the noise, while the 4,000-square-meter area corresponded to the peaks in the stronger signals of the various series. It is important to note that few of the echoes show a depth in range (thickness) of more than five kilometers. This means that the reflection is not broadcast from a considerable length of the ionized cylinder of air.

The meteors (Giacobinids or Draconids) were moving at 22 kilometers (14 miles) a second relative to the earth as they entered the atmosphere, but no changes in range were observed at anything like this rate. The photographs on this page present the only series which showed a striking change: the indicated range decreased approximately 10 km. in nine seconds. The motion at first was still more rapid than this average, two kilometers a second or more. It seems probable that this was the initial speed with which the cylinder of ionization began to expand. It does not appear possible that so high a speed as this could have occurred in the lower atmosphere, at the indicated slant range of 40-50 km. The echo might have been recorded in second scanning, and the range may have been 540-550 km.; the effective reflecting area would then have been from 2,000 to 4,000 square meters.

Mr. Shaffer, in his study of the film, noted a number of other instances of decrease in range, but at slower speeds. Since none of the echoes showed motion

at the meteoric speed, it must be concluded that all were produced from the train of ionized air behind the meteor itself. No special attempt was made to correlate the radar observations with visual ones. Perhaps some trains adequate to make a radio echo remain invisible to the eye.

It must be emphasized, in radio reflection from an ion cloud, that there is no definite surface independent of wave length. Reflection occurs where the density gradient of the ions is sufficient to produce a notable change in the index of refraction over a depth equal to a wave length. Radiation of longer wave lengths may be reflected from a cloud which is penetrated without appreciable reflection by that of higher frequencies.

Since A. M. Skellett's pioneer examination of radio reflections from meteor trains,[2] begun in 1931-32 while he was a graduate student in astronomy in Princeton University, a great deal of work has been done. Space permits only a few references, but additional references are noted in these.[3]

Skellett suggested that the ionization was produced by the kinetic energy of the meteor, and this has been everyone's idea since; but the possibility should not be overlooked that the meteor merely mechanically stirs up already existing ions.

The literature contains evidence[4] that a meteor train gives a mirror reflection as from a reasonably smooth cylinder, and not a broadcast reflection. This means that the angle of incidence at the train must equal the angle of reflection. This in turn requires that there be no reflection observed unless the transmitting and sending stations are properly placed with reference to the limited length of the train. Observations of radio echoes are so easy, with only amateur equipment, that astronomers who have "ham" friends will find it interesting to spend a few hours any night listening for bumps, or sudden increases of many decibels in signal strength of a distant weak station, lasting for a couple of seconds or so — at 28 megacycles, for example. A bump may or may not occur simultaneously with a visually observed meteor. It is best to listen after midnight, because sporadic meteors increase in the later hours.

To "hear" a meteor in this manner is a worthwhile experience. B. S. McCutchen, W. vB. Roberts, J. B. Power are thanked for placing their equipment at the disposal of J. Q. Stewart. Observations of the Geminids, when the radiant was near the zenith, were compatible with the cylinder-mirror reflection theory, inasmuch as no bumps were observed when bright meteors of the shower were seen high in the sky, although bumps were heard in the case of meteors near the horizon.

While many personnel from the Evans Signal Laboratory, Watson Laboratories, and Army Ground Force Board No. 4, Fort Bliss, were involved in the Draconid experiments reported herein, it is particularly desired to acknowledge the co-operation received from Col. James McGraw, Maj. W. D. Prichard, Maj. H. Ostrom, Mr. P. Rosmovsky, and Mr. Merl Worland.

---

[2] A. M. Skellett, *Physical Review, 37,* 1668, 1931; *Proceedings Institute of Radio Engineers, 23,* 132, 1935.

[3] J. S. Hey and G. S. Stewart, *Nature, 158,* 481, 1946; O. G. Villard, Jr., *QST, 30,* 59, 1946; Manning, Helliwell, Villard, and Evans, *Physical Review, 70,* 767, 1946.

[4] Hey and Stewart, *loc. cit.* We are indebted to L. A. Manning, of Stanford University, who in correspondence has emphasized additional information.

LETTERS

Sir:

Many observatories lack a complete set of the BD **(Bonner Durchmusterung)*** charts or have sets which are in poor condition from handling and aging. Recently, we have had a set photostated by the Haire Company of Albany, and the result is quite satisfactory. The photostat negatives were kindly furnished by Dr. Frank K. Edmondson, of Kirkwood Observatory, and are still on hand for use in making further sets, if desired. The scale of each chart is 9/10 that of the original BD set, and although there are a few imperfections (not affecting the stars themselves), the faintest stars are retained in the final prints.

The BD charts, 40 in a set, show all stars to the 9th visual magnitude from the north pole to one degree south of the equator, with co-ordinates for 1855 shown to the nearest degree. By the use of precession tables, these positions are easily corrected to any modern epoch. The charts are most conveniently used, of course, by those having access to the BD catalogue.

Although it is possible to make up BD chart reproductions photographically, the cost and labor are considerably greater than by the photostat method. The Albany firm is willing to make other sets, for $25.00 each, if at least 10 orders are placed by April 1, 1947. This includes the cost of shipping. The price thereafter may increase if supplies become more expensive.

*See Astronomical Anecdotes, **Sky and Telescope**, No. 43, May, 1945, for the story of Argelander and the BD catalogue. ED.

All those interested should communicate immediately with the J. A. Haire Blue Print Co., 110 Hamilton St., Albany 7, N. Y., paying $25.00 by check or money order for each set. Orders will also be accepted C.O.D. Delivery will be made some time after April 1st, and if fewer than 10 orders are received by that date, each individual will be informed of the cost of having his set made before work on the order is begun.

ROBERT FLEISCHER
Rensselaer Polytechnic Institute
Troy, N. Y.

Sir:

In a recent issue of your magazine, Edward Oravec made the incidental remark, "Mercury, which Copernicus is reputed never to have seen, is indeed a fascinating planet to study." This comment raises again the question of whether Nicholas Copernicus did or did not see the shy and elusive planet.

Once a picturesque legend gets under way, although it may be highly improbable, it is extremely difficult to stop. It is unfortunate when authors of repute and standing repeatedly give currency to such myths.

Such a writer as the Astronomer Royal of England, Dr. H. Spencer Jones, to whom we look for a high standard of accuracy, observes rather categorically in **Life On Other Worlds** (1940): "Copernicus died without ever having seen Mercury; he did not have the advantage of the optical aid provided by telescopes, which makes it possible for Mercury to be seen in broad daylight." The Scotch astronomer, Dr. Hector Macpherson, repeats the fallacy in his **Guide to the Stars** (1943). "It is recorded that Copernicus never succeeded in seeing the planet Mercury, although he often tried, the explanation being that he lived on the banks of the Vistula, where the horizon is rarely free from the mists which rise from the river."

Coming nearer home and to more recent times, Marian Lockwood wrote in **Sky and Telescope** in March, 1945, "Many observers have never seen Mercury, and indeed, this is said to have been true of the great Copernicus." But there is little excuse for this assertion in this magazine, as Edward Rosen, in the Copernican centenary issue of May, 1943, was careful to quote from Copernicus' own work, **De Revolutionibus,** on the point, "the ancient observers had the benefit of a clearer atmosphere, for they say that the Nile does not give rise to fogs, such as we get from the Vistula. Nature has denied that advantage to us, the inhabitants of a more rigorous climate, where fair skies are rare and the high latitude permits Mercury to be seen only infrequently." Accordingly, Rosen rightly infers, "From this passage it is evident that there is no basis for the statement sometimes encountered that Copernicus never laid eyes on the planet Mercury."

En passant, one cannot forget that the great 16th-century astronomer spent considerable time under the clear skies of Italy, and a strain is put upon the imagination when we are asked to believe that Copernicus **never** saw Mercury. May the ghost of this fairy tale be never more resurrected.

A. T. G. BRITO
Colombo, Ceylon

NEWS NOTES

By Dorrit Hoffleit

SINGLE-LENS TRIVISION

A remarkable new three-dimensional photographic process, on which the Navy spent about one million dollars during the war, has recently been described by the Bausch and Lomb Optical Company. It was invented by Douglas F. Winnek, optics engineer trained at the University of Rochester. Using a 14½-inch focal length, f/2.2 portrait lens, Winnek achieves pictures amazingly true to life in depth or relief. A lens, like human vision, the inventor points out, can see partly around an object, and hence the larger the lens the greater the depth perception.

Part of this advantage, he says, is lost in an ordinary camera because all light reflections focus on a flat surface. To overcome this loss, he embosses his film, on the side away from the emulsion, with microscopically small ridges the shape of plano-convex cylindrical lenses, numbering 200 to the inch. These supplement the action of the large portrait lens, and can be applied to color film as well as black and white. For maximum relief, the camera is designed to scan the subject, and during the exposure the film is also moved.

This complicated procedure yields pictures that do not look the same when you stand off to the side as when you are directly in front of them: "Objects in the foreground appear to move in relation to objects in the background." The method has been named *Trivision,* and a photoengraving process has been worked out to make possible reproduction of its depth perception. Latest version of the camera was built by the Aero Photographic Experimental Laboratory, Philadelphia Navy Yard.

THE ISAAC NEWTON OBSERVATORY

As president of the Royal Astronomical Society, Professor H. H. Plaskett of Oxford made an address in February, 1946, advocating the revival of observational astronomy in Great Britain and appealing for action for acquiring a large telescope. A suggestion was later made to interest the Committee on Newton Tercentenary Celebrations in a proposed Newton memorial observatory. Members of the Royal Society also became interested, and already on the first day of the Tercentenary celebrations, July 15, 1946, according to the journal *Observatory,* "Sir Robert Robinson, President of the Royal Society, announced that the Chancellor of the Exchequer had agreed to ask Parliament to vote a sum of money adequate to build an observatory to be known as the Isaac Newton Observatory, equipped with a 100-inch telescope . . . ." If approved by Parliament, the new telescope will be government property and available to all astronomers in the United Kingdom.

GROWTH OF THE B.A.A.

At the annual meeting of the British Astronomical Association in October, 1946, figures were presented on the growth of the association during the preceding year. On October 1, 1945, there were 1,401 members, of whom 1,184 were residents of the British Isles. A year later the membership stood at 1,566, with 1,307 representing the British Isles, and 259 from other countries the world over. These figures appear to represent a significant post-war gain in active amateur astronomy.

DISTANCE OF THE ORION NEBULA

Distances of diffuse nebulosities are usually difficult to ascertain accurately — this can be illustrated by the well-known Orion nebula. The values determined by no less authorities than W. H. Pickering, J. C. Kapteyn, R. J. Trumpler, and J. Hopmann, range all the way from 2,000 parsecs down to 180, with the more recent of these determinations lying between 500 and 690.

Recently, R. Minkowski at Mount Wilson investigated the available data. Taking into account the probable constituents of the absorbing dust that discolors as well as obscures the light of the stars imbedded in the nebula, he computed a distance modulus for each of three Trapezium stars. While the amount of obscuration of the three stars is not the same (1.48 to 2.51 magnitudes), their distances are found to be nearly equal. Thus Minkowski places the Orion nebula at 300 parsecs or 980 light-years.

ASTEROID RESEARCH

Dr. Paul Herget, director of the Observatory of the University of Cincinnati, has recently announced a co-operative program for the observation of minor planets in which Dearborn, Harvard, Kirkwood, Lick, U. S. Naval, Warner and Swasey, Yerkes, and other observatories will take part. The program has been set up by the committee on minor planets of the International Astronomical Union, of which committee Dr. Herget is a member.

The prediction of ephemerides of minor planets was seriously curtailed by the war, especially as this work had long been done mostly by German astronomers. Some minor planets have not been observed at all in the past 10 years, so there is considerable doubt that all the asteroids can be identified again. In addition to work on the known asteroids, the new program calls for the search for new ones as part of regular observing procedure.

ADVANCED DEGREES IN ASTRONOMY

President Emeritus Raymond M. Hughes, of Iowa State College, has published a survey of Ph.D. degrees awarded at all the various colleges and universities in the United States for the five years from 1938 to 1942. We have abstracted the following figures, which in some measure indicate the size of the astronomical profession relative to some of the other fundamental sciences. In various fields, the numbers of Ph.D. degrees awarded are:

Astronomy	42
Anthropology	88
Botany	548
Chemistry	3,307
Geology	271
Mathematics	436
Meteorology	10
Physics	798
Physiology	338
Zoology	769

As a hobby rather than as a profession, we venture to guess, astronomy ranks relatively much higher.

THE EARTH'S WOBBLE

Soviet Academician V. Shuleikin believes that the wobble of the earth (wandering of the poles) detected long ago by astronomers may be caused by motions of the earth's own air, according to an Associated Press clipping. Shuleikin and his colleagues estimate that there are 300 billion tons more air over Europe and Asia in winter than in summer. As these large air masses roll back toward the oceans their shifting weight is presumably great enough to cause the earth to wobble.

ATTENTION ALL WRITERS!

Two adjacent articles in the January *Scientific Monthly* merit our attention. Preceding the announcements concerning the AAAS-George Westinghouse science writing awards for excellence in scientific reporting is a paper by astronomer Paul W. Merrill, of the Mount Wilson Observatory, entitled, "The Principles of Poor Writing." He discusses a few essentials for a consistently poor job: ignore the reader; be verbose, vague and pompous; and do not revise.

Amateur Astronomers

An Informative Annual Report

PORTLAND, OREGON, boasts two astronomical societies, each of which is very active and which together collaborate in affairs of mutual interest. The Astronomy Study Group has changed its name to Portland Astronomical Society, and as such is the 21st society to join the Amateur Astronomers League. Fourth group to affiliate with the League is the Portland Amateur Telescope Makers and Observers, whose members seem to carry out energetically the activities implied by the society's name. The report of T. P. Maher, president of the A.T.M. and O.'s, contains so much material of general interest and so many "angles" of possible use to other individuals and groups, that it is reproduced here practically verbatim.

The past year has been notable for several achievements which should put our club on a future road to much progress. The outstanding event of January was the display window in J. K. Gill's, through the goodwill of our member, Hal Johnson, which created much interest in Portland. The reproduction of the photograph on the cover of the March **Sky and Telescope** brought letters from several places in the United States and Canada, Cuba, and Holland; also we had a feature article by Miss Lucille Chapin in the Portland **Sunday Journal.**

September 23rd was the 100th anniversary of the discovery of the planet Neptune, for which plans were made to celebrate the event in Portland. Arrangements had been made to have another window display in Meier & Frank's store, but they cancelled the display a few days before it was to go in. Feature articles were broadcast over Station KEX, and J. Karle arranged a very attractive display case in the lobby of the Main Library.

The next item of interest of the year was the incorporation of the club and adoption of a constitution, which was approved and passed in June and officers and directors elected for the year. During the summer, J. Karle gave a talk to the Salem Geographical Society in Salem, and we made up a party of seven of our members to accompany him. H. Thomas and I took along our 6-inch portables, and H. Carruthers his refractor; then after the meeting the members had a chance to view the heavens and everybody had a good time.

The next major event of the year was the acceptance of the by-laws of the newly organized Amateur Astronomers League, which was the outcome of the convention held in Detroit in July, and which was delayed four years due to the war. We were very fortunate in having Mr. and Mrs. Carl P. Richards, of Salem, as delegates to the convention. I might say that through our fortunately having a meeting of our directors two days after receiving the by-laws of the League, we were the fourth club in the United States and the first in the West to accept and approve them.

The encouragement of the use of our telescopes and accessories after we had them made was furthered by the adoption of four activities which are greatly valued by professional astronomers. **Variable star** work was put under the chairmanship of H. Thomas, who affiliated with the American Association of Variable Star Observers. **Occultations** were put under the chairmanship of N. C. Smale. **Meteors** and **sunspot** charting I took under my wing, and the club affiliated with the American Meteor Society.

The greatest contribution the club made during the year was in reply to a request from N. P. Harmans from Holland, which was due to the window display, asking for the materials to build a telescope. He is in Alphen aan den Rijn, which was totally destroyed by the fighting when our paratroops landed there to cross the Rhine. The members of our club and the Astronomy Study Group heartily endorsed the idea. Through the contributions of D. Connors, A. E. MacIntosh, N. C. Smale, H. Thomas and myself, we collected the materials needed except the pyrex blanks, which were graciously donated by the Corning Glass Company when we wrote them about prices and if they would ship them direct. A copy of **Amateur Telescope Making** was donated by Mr. O. Benson, president of the Study Group, and that club paid for the shipment of the supplies.

(Continued on page 20)

Amateur Astronomers League

As of February 6th, the total number of societies ratifying the by-laws of the Amateur Astronomers League was 29. In addition to the list published last month, the following groups are now members:

Forsyth Astronomical Society, Winston-Salem, N. C.

American Association of Variable Star Observers, Cambridge, Mass.

Bergen County Astronomical Society, Teaneck, N. J.

Tulsa Astronomical Society, Tulsa, Okla.

Wichita Astronomical Society, Wichita, Kan.

Amateur Astronomers Society, Norfolk, Va.

Key West Astronomy Club, Key West, Fla.

Ballots are being prepared for the election of the members of the temporary council.

James B. Rothschild
Box 281, Wharton, N. J.

THIS MONTH'S MEETINGS

Chicago: "Cosmogony, the Beginning and End of All Things" will be discussed by John Sternig, director of sciences of the Glencoe public schools, at the meeting of the Burnham Astronomical Society. The lecture is on Tuesday, March 11th, 8:00 p.m. at the Chicago Academy of Sciences Auditorium.

Cleveland: Dr. J. A. Hynek, of Perkins Observatory, will speak to the Cleveland Astronomical Society on "Astronomy from Above the Earth's Atmosphere," March 7th at the Warner and Swasey Observatory at 8 o'clock.

Detroit: Professor Everett R. Phelps, of Wayne University, will address the Detroit Astronomical Society on Sunday afternoon, March 9th, 3 o'clock, on "Spectroscopy as Applied to Astronomy." The meeting is at Wayne University, and an informal dinner and observing will follow.

Geneva, Ill.: The Fox Valley Astronomical Society, meeting on Tuesday, March 18th, 8 o'clock at the Geneva City Hall, will hear a lecture by the Rev. Carl Bast, of Batavia, Ill., entitled "Dizzy Rides."

Indianapolis: Meeting on March 2nd, 2:15 p.m., at Odeon Hall, the Indiana Astronomical Society will hear a lecture on "Skymarks of the Season," by Dr. Daniel Layman.

Madison: Two talks are on the program of the Madison Astronomical Society for March 12th, when the group meets at Washburn Observatory. "The Telescope, Optical and Mechanical Features," will be discussed by E. P. Baillie; and Dr. A. E. Whitford, of Washburn Observatory, will speak on "Photoelectric Photometry."

New York: Dr. Stephen P. Mizwa, of the Kosciuszko Foundation, will speak on "Nicholas Copernicus," at the meeting of the Amateur Astronomers Association on March 5th, Wednesday, at 8:00 p.m., in the Roosevelt Memorial Building, American Museum of Natural History.

Gordon A. Atwater, curator of the Hayden Planetarium, will speak on the topic, "Navigation — a Challenge to Science," at the meeting of the Junior Astronomy Club on March 28th at 8:00 p.m., in the Roosevelt Memorial Building, American Museum of Natural History.

Philadelphia: At the joint meeting of the Rittenhouse Astronomical Society and the Franklin Institute on March 5th, Dr. Cecilia Payne-Gaposchkin, of Harvard College Observatory, will speak on "The Problem of Pulsating Stars." The meeting is at the Franklin Institute.

Pittsburgh: The regular monthly meeting of the Amateur Astronomers Association, usually held on the second Friday of the month, will be held on the third Friday in March, the 21st. Dr. J. J. Nassau, of the Warner and Swasey Observatory, will talk on "Our Galaxy." The meeting is at 8:00 p.m., in the Buhl Planetarium lecture hall.

Washington, D. C.: Willy Ley, research engineer at the Washington Institute of Technology, will speak on "Space Travel in Our Time?" at the Saturday, March 1st meeting of the National Capital Astronomers. The time is 8:00 p.m., in the Commerce Department Auditorium.

Worcester: On Tuesday evening, March 4th, at 8:00 p.m., Dr. Alice Farnsworth, Mt. Holyoke College, will speak on "Watchers of the Sun," at the meeting of the Aldrich Astronomy Club, in the Worcester Natural History Museum.

American Astronomers Report

Here are highlights of some papers presented at the 76th meeting of the American Astronomical Society. Complete abstracts will be published eleswhere.

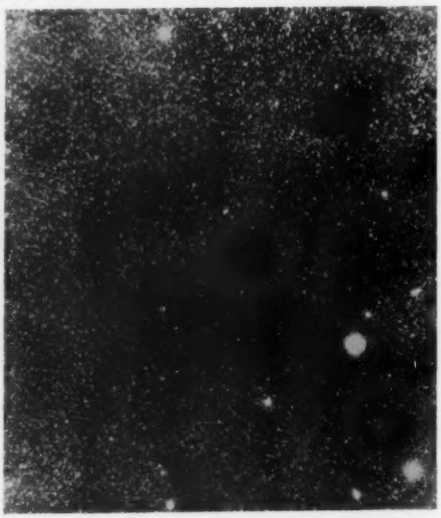
Between the Stars

INTERSTELLAR MATTER was the subject of a symposium of eight papers and the address of the retiring vice-president of Section D of the American Association for the Advancement of Science, Dr. J. J. Nassau, of the Warner and Swasey Observatory. In the last 10 years, such rapid strides have been taken in the study of the bright and dark nebulae in space and of the dust and gas which form the absorbing matter that from the standpoint of the evolution of stars, at least, the subject appears as important as the study of the stars themselves.

Astronomers are generally tending to the belief that stars form from a gradual accumulation of interstellar dust and gas, very slowly at first and then more rapidly. Collisions between particles and gas atoms and molecules in the intense cold of space result in their "freezing" together to make larger particles which become important nuclei for further increase in particle sizes. At a certain particle-size stage, the cloud of matter is subject to radiation pressure from the starlight which is eternally streaming through space and, as the cloud is partially opaque to this radiation, the effect of radiation from all directions is to squeeze the cloud together. As it becomes more compact, it forms what Dr. Bart J. Bok, of Harvard Observatory, calls "globules"; he has definitely observed several score of such masses of obscuring matter along the Milky Way. Another term, "protostar," has been suggested by Dr. Lyman Spitzer, Jr., of Yale University Observatory, for the stage in development which precedes the actual star, and which resembles theoretically the observed globules.

The cosmic clouds are not stationary in space, and they have internal motibns of their own. Collisions between them must occur, and these present unusual problems in theorizing on further evolution. But from a collision between one cloud and another of smaller size containing a few rare and low-mass "planetary" bodies, Dr. Fred L. Whipple envisions a possible origin for the solar system. Thus, the problem of interstellar matter is related to that most common of astronomy's unanswered questions: How did the planets originate?

Dr. Bok, chairman of the centennial celebration committee at Harvard, arranged the interstellar symposium. He pointed out the significance of the fact that Swedish, Dutch, and American astronomers were here given the first opportunity of exchanging news on a subject that has received much attention in Sweden and Holland during recent years and that has rated top priority on the postwar research calendars of a dozen astronomers in the United States. This is a well-conceived trend, for half the matter in the Milky Way galaxy is not in stars but in the grains and gas between the stars.



The S-shaped dark nebula in Ophiuchus and a globule, on a photograph by John C. Duncan at the Mount Wilson Observatory. The upper right portion of the field contains the globule, roughly circular in outline, and with an estimated diameter of 30,000 astronomical units.

Dust — Smoke — Grains?

DUTCH ASTRONOMERS prefer to designate the "solid" portions of interstellar matter as *smoke,* for they point out that *dust* is formed by the pulverization of solid matter, whereas smoke is formed by condensation and accretion. The term *grains* is coming into increasing use by theoretical astrophysicists, who speak of the cosmic grains as the fundamental entities which either become smaller or grow larger with time. The paper on the evolution and physics of solid particles, presented by Dr. H. C. van de Hulst, of Utrecht, Holland, now at Yerkes Observatory, was a general survey of the extensive investigations carried out in Holland during the war under the general direction of Professor J. H. Oort, of Leiden, secretary of the International Astronomical Union.

Solid particles in space must have temperatures of between five and 20 degrees above absolute zero, and the Dutch astronomers believe that each atom of interstellar *gas* that hits a particle freezes to it. Experiments as well as theoretical considerations support this fundamental assumption. (This is directly contrary to the conclusion of Dr. Felix Cernuschi, reported in *Sky and Telescope,* No. 56, page 8, June, 1946.) No appreciable evaporation from the particles will take place, except for the elements hydrogen, helium, and neon. Even so, some hydrogen will be retained in each particle, which will consist primarily of carbon, oxygen, and nitrogen, and will have an irregular structure and a roughly spherical shape.

At this point, the problem of the present average size of interstellar dust particles is important. The work by Dr. Joel Stebbins and his staff at Washburn Observatory, surveying Milky Way stars with photoelectric cells and filters in as many as six colors, has shown that the observed reddening of starlight is produced by tiny particles with dimensions which are comparable to the wave lengths of light, or on the order of 10^{-5} (1/100,000) centimeter. (The increased penetration of infrared radiation is further evidence for this conclusion. In his symposium paper, Dr. Stebbins also gave further data on the detection by infrared light of the bulge of stars near the center of our galaxy, as described last September at the meeting of the American Astronomical Society. See *Sky and Telescope,* No. 61, page 6, November, 1946.)

But an average diameter of 10^{-5} cm. can be attained by cosmic grains in as little as 30 million years, an uncomfortably small interval when compared with the presently adopted age of the galaxy of about 3,000 million years. Dr. Oort has proposed that when two cosmic clouds meet, they will partly penetrate into each other, and in the edges where contact takes place the velocities (random motions of 22 kilometers per second are assumed) will be very much slowed down by collisions among the particles of the two clouds. This will cause some of the particles to break down by evaporation, although a few will increase in size. It is believed this can explain the present sizes of interstellar particles, but further observational evidence, especially in the infrared, is needed before definite conclusions can be drawn.

Protostars and Planetary Formation

THREE STAGES in the evolution of his protostar model were described by Dr. Spitzer, but he emphasized the extremely preliminary character of the picture. In the first stage, atoms other than hydrogen and helium adhere together, forming the *smoke* discussed by the European astronomers. This condensation should take place most rapidly in regions of low temperature (about 100° absolute) and resulting high density. The diffuse clouds of dust and gas thus formed will still contain mostly gaseous hydrogen and helium, because the heavier atoms are relatively rare in space. The density will be about 10^{-24} grams per cubic centimeter.

Radiation pressure acts in the second stage to increase the density to about 10^{-22} grams per cubic centimeter, and the absorption of starlight by the cloud becomes about one magnitude per kiloparsec. The cloud is now apparently similar to one of Dr. Bok's less dense globules, observed principally toward the anticenter of the Milky Way system.

As the cloud continues to contract, radiation pressure gives way in relative importance to gravity, and individual atoms share in the contraction with the dust grains. In each dense cloud, *one or more* pre-stellar masses or protostars, less than a parsec in size, may form, and with sufficient density to make them wholly stable gravitationally. The contraction of these protostars then leads to the formation of stars.

There is danger, however, that a protostar might break up because of rotational instability following contraction. Dr. Spitzer suggests that eddy currents, produced by a possible general magnetic field of the Milky Way, may carry off and counteract the excess rotational motions.

Collisions between large interstellar gas clouds should occur not more than once in 10 million years per cloud, according to Dr. Whipple's analysis of Mount Wilson Observatory measurements of the motions of gases producing "detached" lines in the spectra of distant stars. While these lines furnished the original clue to the existence and nature of interstellar gas by not taking part in the Doppler shift owing to a star's motion in the line of sight, they have been found to have random displacements of their own of roughly five miles per second. The present diameters of these gas clouds are between 100 and 200 light-years. The collision frequency agrees well with that required by Dr. Oort to prevent excessive growth of the cosmic grains in the clouds.

Perhaps as many as 100 or 1,000 million years would be required for clouds of this sort to collapse to radii of a few thousand astronomical units (one A. U. equals 93 million miles), but then, Dr. Whipple points out, the process should be speeded up and dark clouds of radii less than 3,000 to 5,000 A.U. should be rare for masses comparable with the sun.

The development of a planetary system during such a final collapse would require practically zero net angular momentum of the cloud (a double star is more probable otherwise); collision of the cloud at an early stage with a smaller cloud containing partially formed but very rare and low-mass planetary bodies; and more rapid inward spiraling of the planetary masses by accretion than the rate of collapse of the cloud until the stage of rapid collapse.

The resultant planets would move in one plane with nearly circular orbits, those with larger ratios of mass to area remaining at greater distances from the sun. Dr. Whipple's theory also proposes means to account for various other general features of the solar system.

Embryo Stars?

OBSERVATIONAL EVIDENCE of extreme importance to the pre-stellar evolution problem has been found by Dr. Bok, with the collaboration of Edith F. Reilly, of Radcliffe College. In addition to prospecting along the Milky Way for globules, as these compact absorbing clouds are called, these investigators have measured their dimensions and masses, characteristics critical to classification of globules as possible embryonic stars.

The average densities of these objects, particularly of the smallest, most compact globules, are sufficiently high to prevent disintegration by the shearing forces of galactic rotation. Because of the low observed transparency for visual and photographic light, the resultant radiation pressure from the general galactic field will have a tendency to be directed toward the center of the globule. Preliminary estimates show that in the observed stages radiation pressure may outweigh gravitational attraction exerted by the globule at its periphery by a factor of 10.

Some 20 of Barnard's dark objects are of the globule class, and, in addition, more globules are seen projected against certain galactic nebulae. They are most frequent about M8, the well-known diffuse nebula in Sagittarius, where 23 globules have been found, and in the Sagittarius-Ophiuchus-Scutum region of the Milky Way. Those globules near M8 show a preference for diameters between 10,000 and 35,000 astronomical units, while in the anticenter region the globules have diameters as high as 100,000 astronomical units. The minimum absorptions of the smaller globules are two to five magnitudes, whereas some of the larger ones absorb only one magnitude at the most. The corresponding minimum total masses are between 1/100 and 1/10 of the sun's mass, assuming the particle sizes to average 10^{-5} centimeters.

On this Lick Observatory photograph of the diffuse nebula Messier 8, in Sagittarius, the arrows point to typical globules. The scale of this reproduction is such that one millimeter represents 15,000 astronomical units at the distance of this nebula.

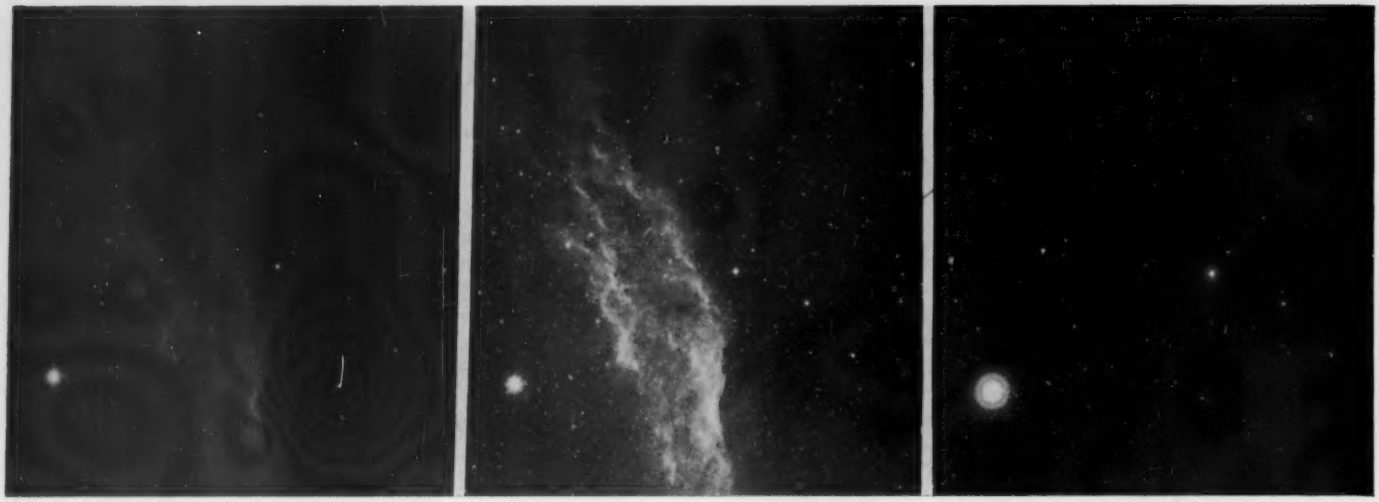
The southern Coal Sack is characteristic of a second class of dark nebulae, large, more massive, and less frequent than the globules. With an estimated diameter of 10 light-years and an average absorption of 1.5 magnitudes, its total minimum mass is of the order of 100 solar masses. It is doubtful that still larger dark nebulae, such as the irregular clouds in Taurus and Auriga, deserve to be considered as single dynamical units.

Meanwhile, astronomers at many observatories continue to carry on systematic surveys of the magnitudes, motions, colors, and spectra of stars to ever fainter magnitude limits. Thus they are extending to greater depths of the Milky Way our knowledge of its structure and motion. In his retiring ad-

CORRECTION

Dr. Karol Koziel writes from Yale University Observatory that incorrect data are reported for measured angular star diameters on page 8 of the November, 1946, **Sky and Telescope.** The sentence beginning on line 16, first column, should read:

"For Nu Virginis, Kappa Virginis, 191 B Ophiuchi, 44b Ophiuchi, the angular sizes are 0.008, 0.005, 0.002, and 0.001 seconds of arc, respectively."



ULTRAVIOLET—Hydrogen Continuum RED—Hydrogen Alpha YELLOW

These three photographs of the region of the California nebula were taken with the Harvard Schmidt telescope. The disappearance of the nebulosity in yellow light indicates the absence of a reflection component in the nebula. Dust may or may not be present in the nebula, although the region of the object is more transparent to distant starlight than are neighboring areas. The nebula appears to be associated with the boundary of the dark cloud, but excited to shine by starlight. In the yellow photograph, some defects in the negative appear as dark splotches, and poor observing conditions have affected the star images adversely. Note that the Schmidt photographs, taken with a reflection from only the primary mirror, give a mirror reversal to the star field.

dress, Dr. Nassau discussed the determination of interstellar absorption from the colors of stars in Cygnus. The results he described were procured in the course of a program in which the 24-36-inch Schmidt telescope at the Warner and Swasey Observatory, East Cleveland, Ohio, is surveying 10 regions of the galactic plane between galactic longitudes 12 and 202 degrees.

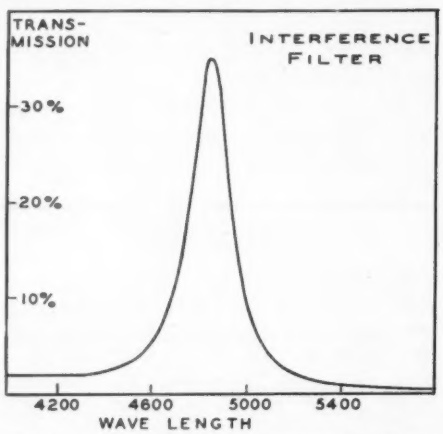
In a region of over 16 square degrees situated on the borderline between the great star cloud in Cygnus and the great rift of the Milky Way, it is found that the unevenness in the surface distribution of the stars is apparently caused mostly by irregularities in the location of the obscuring interstellar matter. The stars themselves are apparently arranged with great uniformity, although a region of excess star density is found at a distance of about 6,000 to 9,000 light-years. The limiting magnitude of the survey is about 12.4, with a number of stars fainter than this limit. The corresponding penetration in depth for relatively unobscured areas of the sky is about 25,000 light-years, at which distance the maximum dimming of starlight is about 2.5 magnitudes. In heavily obscured regions of this Cygnus area, however, the absorption reaches 4.5 magnitudes at 6,500 light-years.

Nebulae and Stars

DO DUST AND GAS have any effect on stars immersed in a nebula? This is the question Dr. Jesse L. Greenstein, of Yerkes Observatory, has tried to answer by spectrographic observations of the Orion and other bright nebulae. He has employed the 82-inch reflector of the McDonald Observatory in Texas, and has found definite effects for certain stars involved in nebulosity.

Some of these stars vary in light, either because the infall of large quantities of gas and dust makes them temporarily brighter, or because veiling clouds drift between the stars and the observer. Bright lines in the spectra of certain of these stars seem to correspond to the lines of elements present in the nebulous gas and dust; this material may be vaporized and made incandescent by close approach to the hot stellar surface. Some faint stars in the Orion nebula show absorption lines of currents of gas streaming by the stars.

Most of the stars which show these peculiarities seem relatively faint. It might be expected that the hottest and brightest stars would be most affected, but no such effects were observed in several *B* stars (15,000° C.) which had 90 per cent of their light absorbed in a nebula. On the other hand, several *A* stars (9,000° C.) showed interesting peculiarities, while stars fainter and cooler than the sun seemed almost always to show emission lines when located in a region of space where dust is found.



This curve shows the transmission of an interference filter in an important region of the visible spectrum. Filters can be made which have their peak transmissions at any desired wave lengths.

Possibly the intense flood of radiation from a hot star blows the gas and dust away from the star's immediate neighborhood, while a cool star permits the material to fall in close, where it may actually strike the star or be vaporized and made luminous near it. Dr. Greenstein suggested that the phenomenon may be similar to that whereby meteors are made luminous by impact with the atmosphere of the earth.

The astronomer from Sweden was Dr. G. Schalén, of Uppsala Observatory, who is the pioneer investigator in the interpretation of the color effects produced by interstellar matter. His paper concerned the results of Schmidt-camera observations of the reflection nebula near Merope, one of the bright stars in the Pleiades. Comparison of photographs in blue and yellow light showed the nebula to be redder than the light of Merope itself, and also indicated the star to be situated outside the illuminated cosmic cloud.

These findings change somewhat our concepts of the action whereby dust produces *reflection* nebulae, such as surround the Pleiades, by reflecting the light of associated stars. Emission nebulae, on the other hand, are those which contain gaseous atoms and molecules which absorb and re-emit starlight in selected wave lengths. Emission neb-

ulae are generally associated with hot, bright stars, but observations currently under way by Dr. James G. Baker, of Harvard, and in collaboration with Simone Daro, a visiting Belgian fellow at Radcliffe College, are aimed partially at surveying all regions of the Milky Way for the existence of emission nebulosities.

Dr. Baker's method is to use narrow filters to isolate those regions of the spectrum in which the characteristic nebular light is emitted, such as the region of the hydrogen-alpha line in the red. He also includes certain portions of the continuous spectrum, and enhances the contrast between nebula and sky fog by means of the selective filters. In one remarkable case, that of the California nebula in Perseus, the picture in H-alpha light shows the nebula's usual structure, but in yellow light alone the nebula is not observable at all. Thus, this nebula seems to be purely emission, whereas the Orion nebula is shown, by photographs in selected colors, to be both reflection and emission and to vary markedly in the distribution of its surface brightness in different wave lengths. Dr. Baker pointed out that in such cases as the California nebula, it is possible to eliminate the emission nebulosity from the sky by photographing in wave lengths between the emission lines, a method first applied by Dr. Otto Struve in studies at Yerkes and McDonald observatories.

Using the light of H-alpha, the prominent emission of most nebulae, and representing the most ubiquitous element in nature, Dr. Baker and Miss Daro have made a survey of a large region 10 degrees south of the Milky Way equator extending from Perseus to Taurus. It was hoped that the 24-33-inch Jewett Schmidt telescope would detect new and faint hydrogen emissions not found on the standard Ross, Barnard, and Lick photographs of the Milky Way. The observed absence of any conspicuous new nebulosity may indicate that the interstellar hydrogen in this section of the Milky Way is in the ground state and unable to send out strong emission in the Balmer series of hydrogen lines.

The accuracy of Dr. Baker's photometry of the sky depends on the selectivity of the filters employed. Glass filters will before long be superseded by filters of the interference type, now available only in sizes up to two inches square, but with effective half-widths of about 150 angstroms and peak transmission efficiency of about 35 per cent. It is impractical to hope for a variety of such filters for the 24-inch aperture of the Harvard Schmidt camera, but it is probable that interference filters up to 12 inches will become available during the next few years. The small filters are now obtainable generally for scientific and commercial uses.

Ask The Moon and It Will Answer

By L. S. Copeland

I am tired of . . . philosophers who . . . meddle in my affairs . . . . Some say I am inhabited . . . others fasten on me anything that occurs to them. . . . Report this to Zeus.
— Lucian (2nd century A. D.)

AMONG CURIOUS NOTIONS that have haunted astronomical thought, few are more phantastic than that which would explain the facial appearance of the moon by the fall of a hundred thousand meteorites and comets. Suggested by Richard A. Proctor in 1873, it long has survived, despite the adverse opinion of experts and the numerous arguments that leap into the eyes of even an amateur surveying the ancient landmarks of our satellite.

The hypothesis of meteoric origin staggers the imagination of common sense. One seems to be in dreamland when he pictures the lunar heavens alive with flying blocks of stone and iron, many of which must have been stupendous enough to have smashed into existence ring mountains and circular walled plains from 50 to 150 miles in diameter. Whence came that super-bombardment of county-busters? Or, changing the figure, let us inquire, "What staged those colossal roundups and rodeos of meteorites and comets by which, we are asked to believe, the lunar terrain was so terribly upturned?"

From Nasmyth and Carpenter, "The Moon," this drawing shows Wargentin, the "plateau" crater, which appears to have been filled up by the flow of lava from beneath it. Nasmyth and Carpenter state that there is no other lunar crater exhibiting this completely filled-up condition.

In the lunar alcove at Griffith Observatory in Los Angeles can be seen two models illustrating suggested causes of lunar formations — one of Crater Lake in Oregon, and the other of the Arizona meteorite crater. These two objects are presented as of similar size. Yet, in fact, Crater Lake is six miles in diameter, while Meteor Crater, that principal argument for the impact hypothesis, is only four fifths of a mile across.

If these figures are multiplied by six, to allow for the weaker tug of gravity on our satellite, Meteor Crater would correspond to a lunar formation about five miles in diameter. When next you look through your telescope at the Sea of Showers (Mare Imbrium), search sharply, between Lambert and the Bay of Rainbows, for Carlini, a crater with an aperture of about five miles. Concerning this detail Walter Goodacre in *The Moon* writes, "Carlini is too insignificant an object to bear a separate name." Here, then, we have the lunar value of that Arizona phenomenon which by its rarity delights motor tourists on earth, but which, if transported to the moon, would be too insignificant to deserve a name among the 672 objects in *Who's Who in the Moon,* published by the British Astronomical Association. With such a puny key, meteoric enthusiasts would open a massive lock.

On the other hand, let us, in imagination, transfer the beautiful Oregon lake to the Sea of Showers. Again compensating for the difference in gravity, we find that this earthly wonder would be 36 miles in diameter, or slightly larger than Aristillus, which Goodacre describes as "a fine larger ring plain" and which we shall notice again and again as through our amateur telescopes we ramble about the moon.

Concerning the meteoric hypothesis, let us ask the moon itself. Let us summon as witnesses the following hills, mountains, and craters:

1. Wargentin, Spoerer, and Jansen. Like a great mesa, Wargentin, close to the southeast rim of the moon, contains a floor lying close to the top of its huge enclosure. Spoerer, just south of Herschel and Ptolemaeus, has a bottom that seems to rise high above the general level and nearly even with the top of the rocky block on which the ring itself stands. Jansen is a spoon-shaped phenomenon, lying on the Sea of Tranquility as if dropped by some careless picnicker. And the inside surface of its bowl is higher than the surrounding sea. In all these cases, bear in mind that meteorites create cavities, not elevations, except for the coping of crater rings.

COMPOSITE OF THE BACK-COVER MOON PHOTOGRAPHS

Bill and George Schuster, of Union, N. J., pieced together the nine "Sky and Telescope" back covers forming the Lick Observatory first-quarter moon, then photographed the composite picture with the result reproduced here. Their first step in mounting the pictures was to paint dull black a sheet of Celotex measuring three by five feet. Then they cut the covers from the magazines and assembled them on the floor, overlapping them to match as well as possible. The sections were held together with rubber cement, and the outside edges and terminator were trimmed to blend properly with the black background, thus giving the subject depth after it was mounted.

The mosaic was photographed with a slow speed Ortho process film with a 500-watt spotlight placed so as not to form any reflection and shining from the same direction as did the sun's rays with respect to the moon itself. The exposure was five seconds at f/9, taken with a Zeiss Tessar f/4.5. The negative was found to be extremely contrasty, and was therefore reduced in intensity. The Schusters recommend use of a medium speed panchromatic film because the original subject is contrasty in itself. The enlargement from which the reproduction was taken was made on No. 1 Defender enlarging paper.

2. The hills of Hell. Advocates of the impact hypothesis report that marbles thrown into mud or bombs dropped upon the earth form, as an after-product, central mountains like those standing within so many lunar rings. How, then, would these theorists explain the five hills of Hell, a ring plain near Walter, or the great inner masses of Copernicus, or the three mountains of Theophilus, or the three mountains of Cyrillus, or the absence of any central peak in huge Plato or titanic Ptolemaeus? And how will they answer when we point out that the Arizona crater entirely lacks a central summit? For even their best terrestrial witness perpetually double-crosses them.

3. The serpentine inner mountain of Purbach. According to Goodacre, the middle of this broken range "is evidently the remains of an ancient ring." But if the meteoric hypothesis were true, this curvilinear ridge would have been produced by a "heavenly visitor" that struck after the great outer ring had been formed. Then the inner mountain should be younger, not older; sharply cut, not ruinous. And how by the back-splash of a sky bomb could have been formed the great ridge that reaches three fourths of the way across the floor of Alphonsus?

4. Perched craters on the rims of Wilhelm, Godin, and especially Cichus. These are relatively small rings astride the brims of larger formations. They could have been created more easily by igneous forces working from below than by impacts from above that pushed out without dashing the rims to ruins. Such terrific impacts probably would have cracked, split, or crumbled a large arc of each ring so bombarded.

Particularly conclusive is the appearance of crater G, which is held high and wide, in equipoise, on the eastern crest of Cichus. What a splendid receptacle for the Hanging Gardens of Babylon, if on the moon one could find a Euphrates to furnish irrigation. Manifestly, a blow from above could not have fashioned crater G, six miles wide, reaching out east and west far beyond the rim on which it rests.

5. Lost rings and partly ruinous circular mountains. Stadius, west of Copernicus, has almost vanished; only a few stumps and lines remain. Another example is the 70-mile circular rampart about Flamsteed in the Ocean of Storms. It, too, has been all but erased by the assaults of the ages. In Fracastorius by the Sea of Nectar, and in Letronne on the Ocean of Storms, we observe circular structures from which a considerable arc has been worn or burned away by powerful agencies of long ago. In this class also is the glorious Bay of Rainbows, 135 miles across, presumably once a complete ring.

These monuments all tell us that the moon also has had a paleo-history. To produce, under the impact hypothesis, both these antiques and the younger, clean-cut mountain circles, great meteoric showers separated by millions of years would have been necessary. But science knows of no such swarms of comets and of no such showers, eons apart. Nor have astronomers ever found meteorites

of the size required by the impact hypothesis. The largest specimen in our museums would not make, if dropped on the moon, a crater large enough to be worth dotting on our lunar maps.

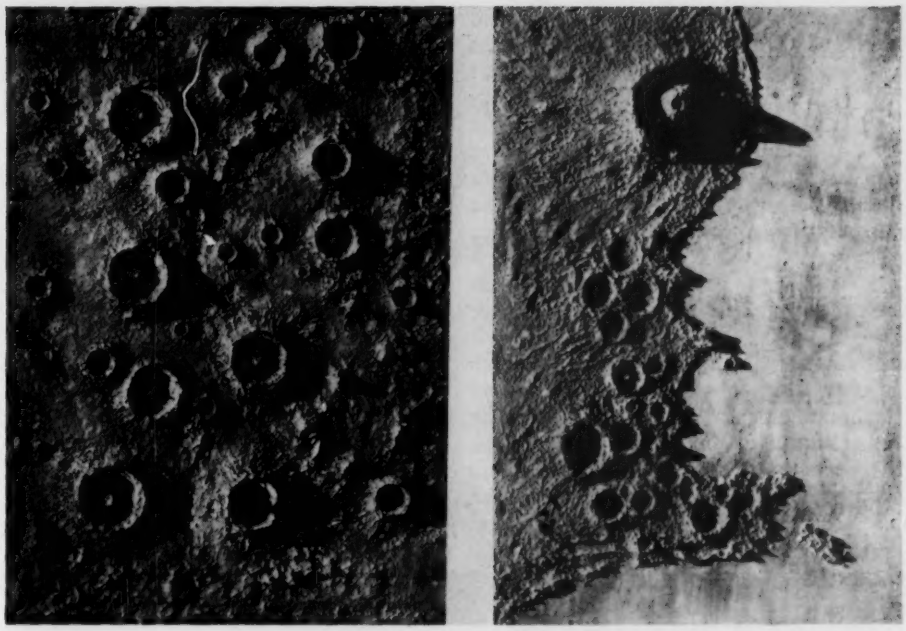
6. Crater chains. Notice the bent line of craterlets south of Stadius and between Copernicus and Eratosthenes. Pretty good shooting for meteorites, would you not say? A choicer specimen, running from crater Z on Goodacre's map, can be seen between Hipparchus and Ptolemaeus. Says Goodacre:

"This chain consists of six or seven craterlets which, starting at about four miles in diameter, gradually taper off in size, the last being about one mile across. The advocates of the impact theory would have us believe that six or seven satellites reached the moon in a curved line with the largest at the head and the smallest at the tail."

Imaginary meteoric marksmanship can boast of nothing more remarkable than crater A on the shoulder of Hesiodus. This is a double concentric ring. But how unlikely that meteorites could cooperate so nicely as to come down one inside of the other, even if we should allow a long interval between the two strikes.

The knockout blow for the impact hypothesis is delivered by the strata of our own earth. If this hypothesis were correct, the earth, as the more massive body, would have drawn in a vaster collection of meteorites than supposedly reached the moon. True, say protagonists, but the ring mountains of the earth have been destroyed by erosion. Indeed, erosion has torn down mountain ranges, but ring mountains are essentially sinks, not elevations. Therefore, erosion would have filled them with debris, just as in the case of the Arizona crater; if we could photograph it in cross section, very extensive filling would be disclosed. Yet geologists have failed to find the numerous great inlays that should exist in the stony beds of earth if in long-past ages this planet had been bombarded by massive blocks of stone and iron.

The region of Aristarchus and Herodotus on the moon's surface. Note the cracks and ranges of mountains to the north and east of the craters themselves. Drawing from Nasmyth and Carpenter.



Here a portion of the moon (left) is compared with a drawing of the region in Italy around Mt. Vesuvius. This is another of Nasmyth and Carpenter's famous models.

Even in a discussion among amateurs we should not stress arguments based on authority. But it is suggestive that of leading selenographers almost none has been a bustling promoter of the impact hypothesis. Maedler, Nasmyth and Carpenter, Moreaux, W. H. Pickering, and Goodacre, all have favored some form of volcanic theory, though not insisting on a single igneous agency. Moreaux has emphasized a highly promising explanation:

"When the moon was in a viscous state, the gases imprisoned in the interior of its mass raised here and there enormous bubbles, thus leading up to the falling in of the surface on a vast scale and in circular and elliptical shapes." Those who watch cereal cooking can sense the force of this suggestion. But probably other fiery agencies co-operated in the construction of lunar topography.

Occasionally it has been urged that the lunar walled plains are too large to have resulted from vulcanicity. Clavius is 140 miles in diameter, Maginus 115 miles, Ptolemaeus and Hipparchus each 90 miles. But volcanic forces on our planet have fashioned Volcano Bay, 35 miles in diameter, in Hokkaido, Japan, and the 20-mile crater of Haleakala on Maui, one of the Hawaiian group. The lunar equivalents, obtained by multiplying by six, would be 210 miles and 120 miles.

Meteoric enthusiasts do not attempt to explain such lunar phenomena as the dome-like hills near Arago, the bent Hyginus and Triesnecker clefts, crooked Schroeter's Valley, the long Straight Wall, the far-flung ridges of the seas of Tranquility and Serenity, and many other features. These marvels speak of cooling and cracking, faulting, folding, exudation, subsidence — all forces directly or indirectly related to igneous or volcanic action.

In short, our earth yields no phenomena that adequately support the impact supposition for the origin of lunar craters. And the moon itself provides a multitude of witnesses whose testimony, in combination, is a mighty *No.*

STAR IDENTIFICATION COURSE

At the Hayden Planetarium in New York City, a series of classes in star identification is being held this spring. Edward H. Preston, planetarium lecturer, employs the planetarium sky to give weather-free observation sessions, and in six meetings covers the sky as it appears at all seasons. March 20th is the date for the beginning of the next series of six meetings, which will again be repeated beginning May 8th.

Other courses already in progress and open to the public are Modern Celestial Navigation, by Curator Gordon A. Atwater; Astronomy Without Mathematics, by Associate Curator Robert R. Coles; and Young People's Astronomy, by Miss Catharine E. Barry.

SEVEN WONDERS O

By Robert R. Coles, H

NEARLY EVERYONE has read of the seven wonders of the world including, among other things, the Hanging Gardens of Babylon, the Colossus of Rhodes, and the Great Pyramid of Egypt. Inspiring as are the stories of these wonders, we are equally impressed by the sad fact that all but one, the Great Pyramid, have disappeared. In a few short centuries these masterpieces of past civilizations have crumbled and gone. Yet, as we look into the heavens we recognize constellations that appear today very much as they did when the most ancient of these monuments was being built. So far as man as an individual is concerned, the stars are eternal. Even the life span of a civilization is little more than an instant when measured on the dial of the cosmic clock where each second is a millennium.

As we search the night sky we are reminded of those famous words from *Hamlet*: "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy."

Certainly there are more wonders in the universe than the most discerning astronomer has seen. But one of the pleasures that man enjoys is that of classifying things in various categories. It was this urge that inspired the listing of the seven wonders of the ancient world. More recently the seven wonders of the modern world have been named. Such a list, of course, is a matter of personal opinion and always subject to criticism.

In the following paragraphs we shall name seven wonders of the universe. Restricting the number to seven makes the task a difficult one. And in this list we deviate somewhat from the usual plan by choosing, in two instances, selected classes of objects in place of the specific objects themselves.

Chief wonder of the universe, as selected by the author, is the solar system. This picture of the sky in the Hayden Planetarium reproduces the unusual array of all five naked-eye planets in the western sky in early March of 1940. Mercury is close to the western horizon in left center. Jupiter is above it and farther left. Next comes bright Venus, then ringed Saturn, and Mars, both high on the left edge of the field. The Great Square of Pegasus is standing on one corner in the lower right, with the Andromeda galaxy, another of the seven wonders, also visible.

Foremost among these wonders we would put the solar system. Its position at the very head of the list is due largely to our ignorance of the universe beyond; up to now, ours is the only known system of its nature. It may be, of course, that many of the stars that we see twinkling in the night sky are attended by planets, as is our sun. But no telescope has yet revealed any such system and in our selection we must confine ourselves to the universe as we know it. For the same reason the earth may be considered unique among the planets. It is the only one on which the more complex forms of animal and vegetable life are known to exist. Also, the sun, which is the controlling force of our solar system, is to us the most important star in the whole universe. It is the one star to which our wagon (the earth) is hitched. It is the principal source of practically all heat, light, and energy that we enjoy.

While the solar system is purposely placed at the head of the list because we consider it the greatest of the seven wonders, the other six are arbitrarily arranged with no attempt to designate their relative importance. As number two we suggest the companion of Sirius. This dwarf star definitely belongs to the "believe-it-or-not" category, and the story of how Bessel, at Königsberg, suspected its existence nearly three decades before it was actually observed is a most interesting chapter in the history of astronomy.

In the year 1834, Bessel observed that the proper motion of Sirius was not uniform, but that it followed a rather irregular course. He eventually concluded that this was being caused by an invisible companion revolving about Sirius, or rather, that the two were revolving together about a common center of gravity.

It was not until 1862 that this faint companion star was actually observed. And its discovery at that time was quite accidental. An American telescope

S OF THE UNIVERSE

OLES, *Hayden Planetarium*

maker named Alvan Clark and his son were testing a new telescope that they were making for the Dearborn Observatory at Evanston, Ill. They turned the instrument on Sirius to test the lens and, while they were observing that star, the son saw, for the first time, the faint companion star whose presence Bessel had suspected 28 years before.

But the story of its discovery is only the beginning of a long list of fascinating facts regarding this star. The orbits of Sirius and its companion are rather elongated and at certain times the angular distance separating the stars is so slight that our best telescopes cannot split them. The period of the companion star is approximately 50 years.

The diameter of this star is calculated as about 30,000 miles, which makes it more nearly comparable in size to a planet than to a star. But, despite its dwarf size, its density has been determined as some 30,000 times that of the sun. This means that one cubic inch of the material of which is it composed would weigh about a ton here on earth! In this star, and in scores of other such dense white dwarf stars found more recently, we have an extreme state of ionization with the degenerate matter of which they are composed packed more densely than in anything imaginable here on earth.

As a third in our list of wonders we include a star that might be considered in many ways to represent the exact opposite of the companion of Sirius. This is the supergiant star Betelgeuse; the colossal sun that shines so conspicuously in the shoulder of Orion is one of the largest stars known. Its extreme diameter is given by Duncan as 460 million miles. This star could hold the sun and the orbits of the planets Mercury, Venus, Earth, and Mars, and there would be several million miles left over between the orbit of Mars and the outer circumference of the star. But we know that Betelgeuse is a pulsating star with a least diameter that is considerably smaller than its greatest diameter. This supergiant is a red star and is composed of such tenuous matter that it would be rated as an almost perfect vacuum in our laboratories.

Next in our catalogue we list the novae that have flared forth from time to time in the heavens. And for the purpose of description we shall mention Tycho's star of 1572, which was actually a supernova that Tycho Brahe observed that year in the constellation Cassiopeia. This star, which had suddenly become visible, rapidly increased in brilliance and finally became at least as bright as the planet Venus, being visible by day as well as by night. Then it began to fade and completely disappeared in about a year and a half. Another supernova was described by Oriental astronomers in 1054 A.D. in the constellation Taurus. The Crab nebula now seen in the sky is believed to be the debris of this object. Many other novae of considerably less brilliance than the supernovae have been observed from time to time in various parts of the heavens. Supernovae occur infrequently in any one galaxy, but they are common occurrences in the universe as a whole.

Nova Persei 1901 is among the best-known novae. In this Yerkes Observatory photograph, nebulosity surrounding the star is shown illuminated by the sudden outpouring of light from the star.

These so-called new stars are today one of the mysteries of the universe. Certainly they are not actually "new stars" as the early observers believed. They are stars that have existed previously and suddenly, for some unknown reason, they flare up to very great brilliance. Perhaps some trigger action sets them off and they explode like huge cosmic bombs, or perhaps there is some other explanation. Actually we do not know. But whatever the cause, these stars have made astronomical history on more than one occasion and, for this and their astrophysical significance, they deserve a place in any list of celestial wonders.

Another class of stars that should not be excluded from our list is that of the Cepheid variables. The prototype of this group, Delta Cephei, may be observed in the northern sky where it is circumpolar for observers in latitudes north of 40° N. Early in the present century, Henrietta Leavitt, of Harvard Observatory, discovered a most interesting and important relation between the period in which these stars vary in brilliance and their actual or intrinsic brightness. Comparison of the apparent magnitude of any Cepheid with its period can therefore be used as a measure of the star's distance, since its period is a measure of its real brightness. First applied to the stars in the Small Magellanic Cloud, the Cepheid method of measuring distances can now be used wherever Cepheid variables are observed, in our own galaxy or in other systems of stars, thus providing the astronomer with a yardstick of inestimable value for measuring the depths of space.

The sixth of these wonders is the Great Nebula in Andromeda, Messier 31. Here, apparently, the Great Architect took pity on the vast population who are without telescopes and placed

(Continued on page 21)

The Great Nebula in Andromeda, a neighboring galaxy of stars. The circles marked on this photograph show the regions where the star density is estimated to be about the same as that around the sun in our own galaxy.

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BOOKS AND THE SKY

SCIENTIFIC INSTRUMENTS

Edited by **Herbert J. Cooper.** Chemical Publishing Co., Inc., Brooklyn, N. Y., 1946. 304 pages. $6.00.

SCIENTIFIC INSTRUMENTS is a book which describes and discusses an enormous number of devices designed for making physical measurements. In five sections, written by 15 contributors, it deals with optical instruments, measuring instruments, navigational and surveying instruments, liquid testing, and miscellaneous devices in the fields of acoustics, calculating machines, hardness indicators, and vacuum tubes. Under these broad categories are to be found discussions of many devices of interest to the amateur astronomer in the construction and understanding of astronomical instruments.

In the 106-page section on optical instruments, for example, there are chapters on lenses and their properties (which include discussions of the common image defects such as spherical aberration, chromatic aberration, and so forth), as well as descriptions and drawings of various forms of eyepieces and of telescope, camera, and microscope objectives. There are, in addition, chapters on telescopes, cameras, and microscopes (including the electron microscope) considered as complete instruments. Other chapters in this section deal with photometers (generally of the non-astronomical type), spectrographs, range finders, polarimeters, refractometers, and interferometers.

In the section on measuring instruments are discussions of devices for determining many of the more common physical properties of matter such as size, temperature, pressure, density, and so forth. Of particular interest to the astronomically minded reader is the chapter on clocks and time determination. Descriptions of the Synchronome-Shortt free pendulum clock and the quartz crystal clock, both of which are to be found in the modern observatory, are included.

The descriptions of many of the navigational and surveying instruments (among which are discussed gyroscopic devices) and of computing machines of the simpler type will likewise be of interest to the amateur astronomer.

Scientific Instruments has a wide appeal — it may be read with pleasure by anyone interested in accurate scientific mechanisms. The descriptions of such mechanisms and the explanations of the principles on which they are based are given in simple language easily understood by all. Possible criticisms of the book are of a very minor nature.

Though there are numerous diagrams included with the text, it is felt in a few instances that an additional diagram might have simplified greatly the verbal description of the device under consideration. The printing of the photographs included is in a few cases not of the highest quality.

While no two writers or groups of writers would make quite the same selection of material to include in a book of this kind, there are, in **Scientific Instruments,** some rather surprising omissions. In the chapter on optical instruments, for example, there is no discussion of the advantages to be gained through the application of anti-reflection films to optical elements; neither are there any descriptions of the various methods of applying such films to glass surfaces. The book has been written by a group of British authors, and in the text, references are to standard British tests of various kinds. No references are made, unfortunately, to the analogous standard American tests.

A word of praise must be said for the index. It is large and complete, and with its aid one can readily find all information on any subject covered in the text.

HAROLD F. WEAVER
Lick Observatory

THE SOOCHOW ASTRONOMICAL CHART

W. Carl Rufus and **Hsing-Chih Tien.** University of Michigan Press, Ann Arbor, 1945. Two plates and 24 pages. $2.50.

ALTHOUGH there have been disputes, at various times in the past several hundred years, as to the actual astronomical knowledge of the ancient Chinese, it is fortunately not the province of this reviewer to evaluate this problem in dealing with the work under consideration. It must be remembered, however, that the observation of the stars and the movements of the sun and moon among them, were necessities to ancient man. "Calendaric problems directed the first steps of astronomy." And there is evidence, both internal and external, tending to prove that many of the asterisms indigenous to the Chinese are very old, particularly the scheme of lunar mansions, which, undoubtedly, dates back to at least the 24th century B. C. The directions of Yao to the brothers Hsis and Hos concerning Alphard, Graffias, Sadalsuud, and the Pleiades, could not be the invention of a later age of astronomers who were un-

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aware of the precession of the equinoxes.

The chart under discussion and the text accompanying it constitute "a presentation and practical explanation of the astronomical or astrological system for the use of an emperor." These instructions, which were prepared in 1193 A.D., were engraved on stone in 1247, after the capital of China had been removed to Kai-Feng Fu in Honan; this accords with the latitude of the observer as indicated by the star chart.

Examining the text first, we are told that before the Great Absolute had unfolded itself the three primal essences, Heaven, Earth, and Man, were involved within it. This "evolves into the sun and the moon, divides into the five planets, arranges in order as the twenty-eight mansions, and meets to form the directors (Ursa Major) and the circumpolar stars."

The sky is then briefly described. The equator is called the Red Road, which "transversely encircles the heart of Heaven and is used to record the degrees of the twenty-eight mansions." The ecliptic is called the Yellow Road, and is the path that the sun travels. It crosses the Red Road, "extending half within and half without." The obliquity of the ecliptic is described as 24 degrees. The moon's path is called the White Road, which crosses the Yellow Road and is half within and half without, but not more than six degrees. The Milky Way is, of course, called the River of Heaven.

The fixed stars include the three walls or enclosures, called Tzu-Wei Yuan, Tai-Wei Yuan, and T'ien-Shih Yuan. The aforementioned lunar mansions are distributed amongst the four divisions, outside the circumpolar stars, which are designated the Blue Dragon, the Spirit Tortoise (sometimes called the Dark Warrior), the White Tiger, and the Red Bird.

The planets are the essences of the five elements: Saturn is known as the earth planet, T'ien-Hsing; Jupiter as the wood planet, Sui-Hsing; Mars as the fire planet, Ying-Huo; Venus as the metal planet, T'ai-Pai; and Mercury as the water planet, Ch'en-Hsing. These, with the sun and moon, are called the Seven Directors, a name also applied to the seven brightest stars in Ursa Major.

The authors count 1,440 stars on the chart, and in attempting to identify the individual stars, it must be remembered that Oriental star maps make unlimited use of the principle of "idealization," the art of making the form of the asterism fit the name or the idea it is supposed to represent, all "for the instruction of a future emperor of China."

The names of the asterisms, in general, are the same as those given by Williams and Reeves and my good friend Peter Chin, of Buffalo. It is a little disappointing, however, to find that the names of all the asterisms were not transliterated according to the excellent system adopted by the authors; but my disappointment is hardly a criticism. Several typographical errors may, incidentally, be pointed out. The second Sieu, or lunar mansion, here called "the neck," sometimes translated "the shelter," includes Eta Virginis: this should read Lambda Virginis, Eta being too far to the west. The seventh Sieu, called the Sieve, or the Winnower, according to Chin, here includes Beta Telescopii: there is no such star, and Eta Sagittarii is undoubtedly intended. It is good to find the 19th Sieu called the End, or, according to Chin, the House of Completion, instead of the Net, as we see frequently, obviously signifying the completion of the circuit of the moon in very ancient times.

The authors conclude their description of the chart by saying that the asterisms follow the traditional Oriental pattern, which differs widely from the Occidental. "Instead of the predominant mythical heroes of the West, including supernatural or superhuman personages, we find real terrestrial beings personified, especially the emperor, his court, and numerous officials, civil and military."

This work is a magnificent piece of research, and, as a student of the history of the constellations amongst all peoples, I extend to Hsing-Chih Tien sincere and hearty congratulations, and, to the memory of Carl Rufus, my humble respect and admiration for work well done.

GEORGE A. DAVIS, JR.
Buffalo, N. Y.

NEW BOOKS RECEIVED

THE PATH OF SCIENCE, *C. E. Kenneth Mees*, 1946, *Wiley*. 250 pages. $3.00.

A review of the evolution of scientific thought and the various social factors influencing the growth of physical, chemical, and biological ideas. The principal author is vice-president in charge of research for Eastman Kodak Company.

A CATALOG OF PROVISIONAL COORDINATE NUMBERS FOR THE METEORITIC FALLS OF THE WORLD, *Frederick C. Leonard*, 1946, *Univ. of New Mexico Press*. 54 pages. $1.00.

With the assistance of Boris Slanin, Delia M. Herbig, and John W. Handin, U.C.L.A. astronomer Frederick C. Leonard has catalogued provisionally 1,347 meteoritic falls of the world which were on record as of January 1, 1946. The co-ordinate number contains four digits for the longitude and three for the latitude of the fall, and the falls are enumerated alphabetically by their place names under their respective countries and continents.

There is a list of principal references from which the bulk of the catalogue information has been derived. Eleven authenticated meteorite craters and groups of craters of the world are listed, four in Australia, three in the United States, and the others in Arabia, Argentina, Estonia, and Siberia.

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6—Sectional view thru the earth showing the pressure at earth's core, etc.
7—Twenty of the brightest stars and their distances.
8—Our solar system in a nut shell. Shows our relative distance to other stars.
9—Our location in the Milky Way Galaxy, and time to reach the nearest star.
10—Curvature of the earth with comparative heights and depths.
11—A drawing showing the way of measuring the distance to near stars.
12—Showing movement of comet tails, and their paths thru outer space.
13—The Moon. Temperatures, distance, diameter AND OTHER INFORMATION.

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Gregorian Variations and a Compound Eyepiece

A NOTE in **Scientific American** "Telescoptics" contributed some time past by C. H. Helm, an electrical engineer in Copenhagen, and commented upon by N. J. Schell, Beaver Falls, Pa., describes one of those oddities in telescopes which amateurs frequently think up, not with the intention of producing anything of increased value, but just to "see if it will work."

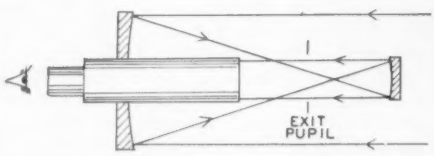
The instrument described is a Gregorian telescope wherein the distance of the secondary from the primary focus is equal to its own focal length, causing the secondary to reflect the light in parallel bundles. A small refracting telescope is then placed in the hole in the center of the primary to view the image. This is an interesting idea, but it is doubtful if there is any advantage to be gained from it as it is described, and this seems to be the conclusion of both Mr. Helm and Mr. Schell.

Each of them, however, has either overlooked or failed to mention what seems to us to be the most important feature of the arrangement, namely, that the Gregorian system as described constitutes a complete telescope in itself. The view telescope is an unnecessary accessory, for we may place our eye at the hole in the primary and view whatever we like. The image will be erect, thereby making it useful for terrestrial observation, and the magnification will be whatever we want to make it, being the ratio of focal lengths of primary and secondary. The secondary mirror, in this arrangement, functions as an eyepiece.

Of course, the significance of the idea is that here we have a visual telescope which is completely free from chromatic aberration — even from that last vestige which is introduced into other types of reflecting telescopes by the eyepiece. At the same time, other aberrations introduced by frequently inferior and invariably inadequate eyepieces are avoided. For certain types of observations, notably of planetary features, this complete freedom from color might outweigh the obvious disadvantages of the design.

The two overwhelming disadvantages are, of course, a severely restricted field of view and a large loss of light. At best, the field of view of a Gregorian telescope leaves much to be desired, and we have the further complication that the exit pupil is inside the telescope, close to the secondary mirror. The loss of light is evident in the diagram (assuming the view telescope to be omitted), and will ensue unless we make the diameter of the secondary mirror equal to that of the pupil of the eye — about 1/3 inch. The exit pupil could be brought back to the surface of the primary if the instrument were of unit power, in which event the secondary would equal the primary in diameter, and would block out all the light.

The view telescope provided by Mr.



A diagram to illustrate the Gregorian which produces parallel light from its secondary mirror.

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comments, contributions, and questions from its readers.

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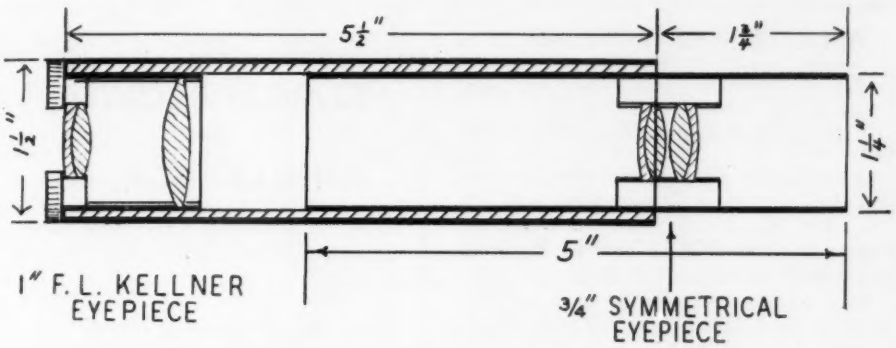
Helm relieves the situation somewhat, inasmuch as he mounts its objective lens closer to the exit pupil than the eye could come, thereby attaining more nearly the complete field of view of the Gregorian combination.

We have not studied the idea in detail, but the situation might be remedied by a suitable design — perhaps by a strategically situated diaphragm. In any event, it is something for the amateur telescope designer to ponder. E. B.B.

I HAVE CONSTRUCTED a short focal length compound eyepiece and have found it very useful for planetary and lunar observations. This type of eyepiece is not new, but its advantages with small Newtonians of short or average focal length may not have been realized. Also, good quality fluoride coated lenses are now obtainable at reduced prices and these greatly improve an eyepiece of this type. All the lenses used were coated and obtained at about half the price of a good Ramsden ocular.

The effective focal length is variable from approximately 1/8 to 3/10 of an inch. The eyepiece is a form of low-power compound microscope, with a 3/4-inch focal length symmetrical eyepiece as the objective and a 1-inch Kellner as the eyepiece. Any kind of low-power eyepiece may be used in place of the Kellner, but if its eye lens is small the field may be restricted somewhat. The diagram shows the construction. The larger tube is lined with felt so that it makes a snug fit with the 1¼-inch tube. The power of the eye-



The short focal length eyepiece devised by Gerard Ochs. Although it permits high magnification for observations of the moon and the planets, this eyepiece has the eye relief of an eyepiece of low power.

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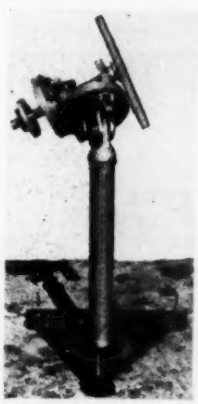

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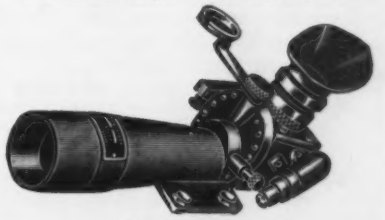

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piece can then be changed by sliding this tube in or out. Effective focal length can be calculated from the formula:

$$\text{E. F. L.} = \frac{F_o \, F_e}{d - F_o},$$

where F_o equals the focal length of the objective, F_e that of the eyepiece, and **d** is the distance from the center of the objective to the focal plane of the Kellner eyepiece.

As a whole, the eyepiece seems to have better definition than an ordinary Ramsden eyepiece. The field is perfectly flat, though bright objects such as Venus may show slight color errors off axis. The real advantage is being able to use a high power and still have the eye clearance a 1-inch ocular gives. Anyone who has squinted long through a ¼-inch eyepiece will readily appreciate this. In practice it will usually give a larger field, not because the field is much larger, but because an observer usually doesn't put his eye close enough to a high-power eyepiece to take in all the field.

It will be noted that magnifications greater than 50 per inch of aperture are possible with f/8 mirrors. After this point no more detail can be seen by increasing the magnification; however, I find that, on nights when good seeing exists for only a few seconds at a time, more detail can be observed in a shorter time with powers as great as 60 or 70 per inch with a 6-inch mirror.

GERARD OCHS
627 Randle St.
Edwardsville, Ill.

AMATEUR ASTRONOMERS

(Continued from page 7)

During the year we lost some of our members: Fred Falk moved to Los Angeles, Harry Sprague moved to Denver, and Hal Johnson to Cannon Beach. While we have not heard from Hal, we are hoping to hear that he has not deserted us altogether.

The problem of a central workshop has been pursued during the year but without results. Some of us have still to be very thankful to our generous secretary-treasurer for the use of his home.

Activities in the telescope making field were greatly accelerated after the window display. Mrs. Huddleston started a 6-inch mirror, but before she had finished she moved out of town and we lost track of her. F. G. Davis completed a 6-inch and is now working on a rigid mount for it. H. Thomas started a 12½-inch mirror for a Cassegrainian, but is now figuring on using it for a Schmidt camera. N. C. Smale is making another 10-inch for a Cassegrainian, and making drawings for an observatory.

J. Karle has a tube ready for his 10-inch and is now working on his mirror cell. Thompson has yet to finish his 10-inch, but he is sticking to it. I will not say much about H. Carruthers' 6-inch as he has made himself a finder and solarscope, acquired a 2¾-inch refractor for the year, and allowed Thomas and myself the use of his lathe and drill press at his place of work. Mr. Winthrope has finished an 8-inch pyrex flat to within one-quarter wave length of flatness.

H. Thomas and I, mostly H. Thomas, finished the refiguring of my 4¼-inch mirror. Smale, Thomas and I removed the scratches of Benson's 6-inch and had it just about polished when we got another scratch and are now going to finish his pyrex mirror instead. I also made a polaroid adjustable filter and hope soon to have my Foucault tester finished.

H. Thomas brought his mount down from Spokane and made a new base for it, and I made a miniature base for my solarscope similar to Harry Sprague's. Thomas and I hope soon to have circles and slow motions on our 6-inch mounts.

I finished my meteor camera, using the combination lens picked up in Regina last

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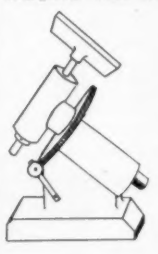
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year, and up to the time of the meteor shower I had taken 56 exposures with no trails registered, but I was well repaid during the shower of October 9th, for it gave me 20 trails on one film exposed 10 minutes. In addition, meteor counts in five-minute intervals were made by a small party at A. E. MacIntosh's home, and H. Thomas and L. Shaffner also took photographs. We also made hurried arrangements with Carl Richards for photographic records of the shower by pointing our cameras at approximately the same spot in the sky, but owing to the shortness of time and inexperience we did not succeed as well. However, all information and pictures have been sent in to the American Meteor Society.

Several occultations have been reported to Harvard Observatory, and H. Thomas has sent in some reports on variable stars. I have also sent in two months' reports on sunspots to the Solar Division of the A.A.V.S.O.

All the above activities have been started rather late in the year, but we hope to obtain some really worthwhile results in 1947, when possibly more members will become interested.

H. Thomas during the past summer has tried some photography using A. E. MacIntosh's telescopes with encouraging results. With the new 6-inch achromatic lens and 20-foot focal length telescope which MacIntosh is acquiring and should have mounted in 1947, better results are looked for.

We cannot let this year close without acknowledging our thanks to the following: Mr. Benson for incorporating the club without remuneration, F. W. Meyer, who donated stationery and envelopes with the club's name, the J. K. Gill Company for the use of their window in collaboration with Hal Johnson, the Public Library for the use of the central display case, to both the newspapers and to J. Karle for the large amount of work he did to put across the birthday of the discovery of Neptune, besides another birthday he added to his own family.

A few anecdotes, without names, may not be amiss in this closing portion of my report.

At one of the occultations, one observer after punching his stop watch, came inside to figure the time and found that he had not wound up the watch.

Another, after sitting two hours and being very careful with the slow motions to ensure a good picture, found that he had not pulled out the slide from the film holder.

Another photographic one: After exposing two films for star trails, the operator, a different one this time, found he had put the films in the holder with the emulsion side inward.

Still another one: This person must have been looking at Aries through the 20-inch, because he butted his head against the wall and left a trail of blood down the steps of the observatory to reach the water tap outside.

SEVEN WONDERS OF THE UNIVERSE

(Continued from page 15)

this galaxy within range of the naked eye. This magnificent object may be seen during the autumn and winter months as a hazy patch of luminosity in the constellation Andromeda. Although not an impressive sight, even when observed through a telescope, it is revealed magnificently when photographed through a large instrument with an exposure time of several hours. Such pictures show it as a tremendous galaxy that is roughly comparable to our own Milky Way galaxy. It might almost be considered as a mirror image of the universe to which we belong, although probably somewhat smaller and with a lesser stellar population.

Duncan gives the distance of M31, as determined from the period of its Cepheid variables, as about 805,000 light-years. Its diameter is estimated as some 60,000 light-years, while the diameter of our galaxy is about 100,000.

Finally we might include in our list the interesting phenomenon of the red shift as observed in the spectra of the distant extragalactic nebulae, some of which are observed as much as 500 million light-years away. The interpretation this suggests is that of an expanding universe, with the velocity of recession becoming increasingly greater as the outer galaxies are approached. Whether or not this interpretation of the red shift is correct, the idea of an expanding universe appeals to the imagination. It emphasizes the truth that the marvels of the cosmos are infinite in number and that each new discovery merely reveals an endless train of mysteries beyond.

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OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

Jupiter Occultation Reports

EASTERN OBSERVERS had cloudy skies on January 16th, but from other parts of the country accounts of successful observation of Jupiter's occultation were received. Some of these reports are abstracted here. At Merced, Cal., R. M. Blalack observed and made drawings of the event with the naked eye, in 10x binoculars, and in a 4-inch refractor, using 60 power, with the seeing about 5.

The occultation of Jupiter on January 16th was observed by the Rev. Claude Hall and myself from Napa, Cal. Immersion took place at 3:54:15 PST, and emersion at 4 51:42. It took Jupiter a minute and 33 seconds to disappear, and nine seconds longer to reappear. At immersion, the moon's limb was boiling because of a turbulent atmosphere, but at emersion the seeing was much better. We were able to get the emersion of two of the moons, IV at 4:46 and III at 5:00:30. It was a beautiful sight to see Jupiter and its four moons alongside the dark limb of our moon.

FRANK TRATHEN
Napa, Cal.

I observed the occultation of Jupiter from a place in Des Moines at latitude 41° 35′, longitude 6^h 15^m. The immersion of the planet was to take place at 6:18.5 CST. I first began observing about five minutes before this, at which time satellites I and IV were barely visible because of the moon. As Jupiter approached the moon, the lunar limb seemed to flatten out, until a space of five or 10 degrees looked nearly straight. The exact instant of immersion was hard to determine, but from the average of the times of immersion of the two limbs — immersion lasting about 40 seconds — the observed time was found to be 6:16.2, or a little over two minutes off from the predicted time. The position angle was as calculated, 103°.

The instrument used was a 2-inch achromatic refractor, with a 1° field of view. I began looking for emersion about five minutes before the calculated time of 7:38.0 for Jupiter's western limb. I had planned to time the emersions of satellites III and II, but the daylight blotted them out. I noticed third contact about 10 seconds before 7:38:10, the exact time at which I attempted a photograph. I took a second picture at 7:39:06, slightly after the planet was half uncovered, and a third at 7:39:40, when emersion was completed. Jupiter appears on the last two photographs, but without shape because of its small size.

I have never seen any phenomenon quite like the emersion of Jupiter. The leading edge of the planet appeared suddenly in bright blue sky, the segment rapidly increasing in size. The dark occulting edge of the moon was slightly fuzzy, the limb of the planet noticeably more so. After emersion I could plainly see Jupiter in the bright daylight. A naked-eye observer said, "It was sudden and without warning. The light didn't seem to wax gradually, as might be expected."

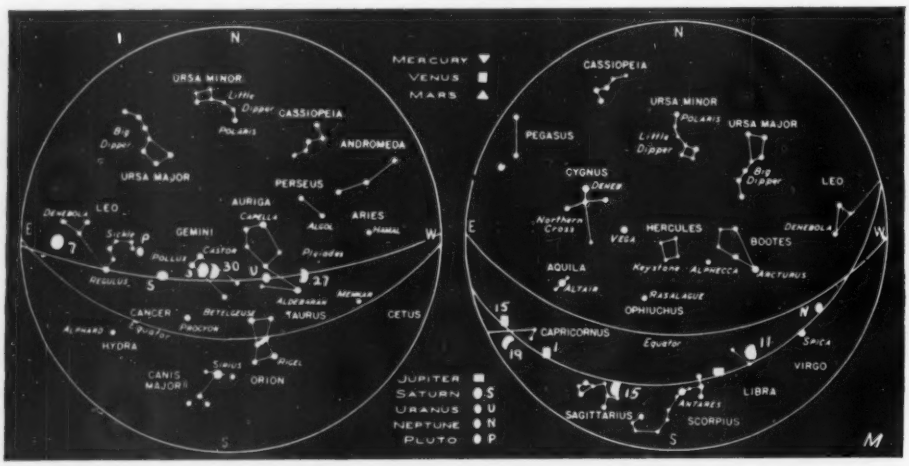
About one hour after the end of the occultation, I attempted unsuccessfully to see Jupiter without optical aid. The sunlight by this time had become too intense to make it out.

ROBERT DAVIS
Des Moines, Ia.

This morning's occultation of Jupiter was completely clouded out in the Rochester area. A break in the clouds near sunset January 15th, after a rain all day, was short-lived when fog set in by 7 p.m. and covered the region all night. Preparations for observing the phenomenon had been made by several of our members. The article in the January issue of **Sky and Telescope** concerning the occultation was exceedingly interesting.

PAUL W. STEVENS
Rochester, N. Y.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 5:30 a.m. local time on the 7th of the month, and at 4:30 a.m. on the 23rd. At the left is the sky for 7:30 p.m. on the 7th and 6:30 p.m. on the 23rd. The moon is shown for certain dates by symbols which give roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury passes inferior conjunction with the sun on March 8th, and will not be visible till the closing days of the month, when early risers may glimpse the planet about an hour before sunrise; magnitude +0.8.

Venus remains a brilliant morning object, rising from two to 1½ hours before the sun. On the 1st, it is of magnitude −3.8, decreasing to −3.6 as the planet approaches the sun.

Earth reaches heliocentric longitude 180° as the sun arrives at the halfway point on its journey northward, the vernal equinox, on March 21st at 11:13. Spring commences in the Northern Hemisphere and autumn in the Southern. The days and nights are equal throughout the world.

Mars has not increased its apparent distance from the sun enough to be visible.

Jupiter rises about midnight and is becoming a more prominent object in the late night sky. By the end of March its magnitude has increased to −1.9, exceeded only by Venus. At sunrise Jupiter is past the meridian. It is almost stationary all month, close to the head of Scorpius.

Saturn and Uranus are the only two evening planets. At sunset Saturn is high in the eastern sky. It continues its retrograde motion in Cancer, and its magnitude is about +0.2.

Uranus can be found in Taurus with slight optical aid during the evening hours. Its position is 5^h $7^m.3$, +22° 59′, on the 15th.

Neptune reaches opposition on March 31st. Its position on that date is 12^h $37^m.2$, −2° 19′, and it is at magnitude +7.7.

E. O.

VARIABLE STAR MAXIMA

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0 Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

VARIABLE STAR MAXIMA

March 6, S Carinae, 5.7, 100**61**; 6, X Centauri, 7.8, 114**41**; 19, T Normae, 7.4, 153**54**; 24, R Virginis, 6.9, 123307; 25, S Virginis, 7.1, 132**706**; 26, U Ceti, 7.5, 022**813**; 27, T Cephei, 5.8, 210868. April 2, R Octantis, 7.9, 055**86**.

GREENWICH CIVIL TIME (GCT)

TIMES used on the Observer's Page are Greenwich civil or universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the GCT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

PHASES OF THE MOON

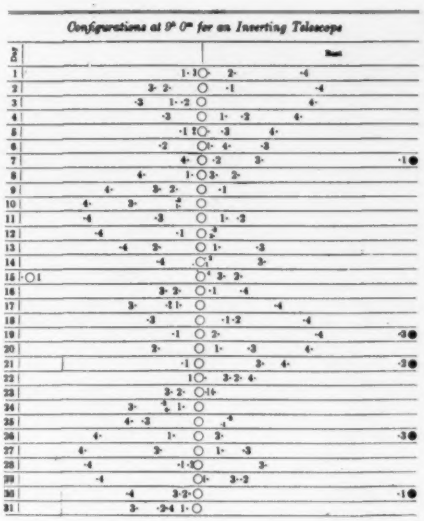
Full moon	March	7, 3:15
Last quarter	March	14, 18:28
New moon	March	22, 16:34
First quarter	March	29, 16:15
Full moon	April	5, 15:28

MINIMA OF ALGOL

March 3, 17:47; 6, 14:36; 9, 11:25; 12, 8:15; 15, 5:04; 18, 1:53; 20, 22:42; 23, 19:32; 26, 16:21; 29, 13:10. April 1, 9:59; 4, 6:49.

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the GCT given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. Reproduced from the American Ephemeris and Nautical Almanac.



EDDINGTON'S SUCCESSOR

The Plumian professorship of astronomy and experimental philosophy at the University of Cambridge, England, the chair held by the late Sir Arthur Eddington, has (according to *Nature*) been awarded to Harold Jeffreys. This theoretical geophysicist has achieved international renown in many scientific fields. He has won prizes and medals not only for his astronomical work but also from the Royal Meteorological Society and the Geological Society, and has written books on probability theory and geophysics. His best known work, *The Earth*, was dedicated in 1924 to another past Plumian professor, Sir George Darwin.

OCCULTATION PREDICTIONS

March 2-3 **A Geminorum** 5.1, 7:20.2 +25-09.3, 10, +65° 0° Im: **A** 3:18.4 −1.5 −1.0 96°; **B** 3:14.4 −1.6 −0.6 88°; **C** 3:15.7 −1.6 −1.5 112°; **D** 3:06.3 −1.6 −0.8 98°; **E** 2:49.7 −1.9 −1.3 118°; **G** 2:13.4 −1.2 +1.4 77°; **H** 1:56.3 −1.8 −0.5 123°.

11-12 **41 Librae** 5.5, 15:35.9 −19-07.7, 19, +71° −3° Em: **E** 12:48.4 −1.4 −3.0 348°; **F** 13:03.3 −1.9 −2.3 320°; **G** 12:01.6 −0.8 −1.3 342°; **H** 12:11.1 −1.8 −1.0 308°; **I** 11:54.9 −1.0 −0.7 327°.

29-30 **40 Geminorum** 6.3, 6:56.2 +25-59.3, 7, +44° −14° Im: **A** 23:52.7 ... ... 21°; **C** 23:28.3 −2.1 +2.5 47°; **E** 23:07.2 −1.3 +3.7 36°; **F** 22:33.5 −1.5 +1.6 70°.

April 1-2 **Eta Leonis** 3.6, 10:04.4 +17-01.3, 9, +55° −23° Im: **C** 3:22.2 −3.3 +1.4 64°; **E** 2:46.2 −2.2 +0.5 86°; **F** 2:35.5 −1.9 −1.3 129°; **G** 2:22.5 −1.3 +3.2 58°; **H** 1:56.1 −1.2 0.0 118°. Em: **C** 4:03.6 +0.3 −4.1 357°; **E** 3:53.4 −1.0 −2.5 332°; **F** 3:59.1 −2.2 −0.9 290°; **H** 3:10.9 −1.7 +0.2 285°.

2-3 **BD +12° 2284** 6.4, 10:56.9 +11-59.4, 10, +55° −27° Im: **A** 2:23.4 −3.0 +2.3 64°; **C** 2:06.9 −2.2 +0.7 89°; **D** 2:07.6 −2.4 +1.9 72°; **E** 1:41.9 −1.5 +0.6 100°; **F** 1:34.9 −1.2 −1.2 140°; **H** 1:12.2 −0.5 +0.2 119°.

3-4 **Nu Virginis** 4.2, 11:43.1 +6-49.6, 11, +56° −28° Im: **A** 23:06.3 −0.5 +0.9 104°; **C** 23:01.8 −0.4 +0.4 117°; **E** 22:59.2 0.0 +0.6 111°.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, limiting parallels of latitude, immersion or emersion; standard station designation, GCT, a and b quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +30°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0
I +123°.1, +49°.5	

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

For additional occultations consult the American Ephemeris and Nautical Almanac and the British Nautical Almanac, from which these predictions are taken. Texas predictions were computed by E. W. Woolard and Paul Herget.

The INDEX for Volume V

is now ready for mailing. Its style is similar to previous indexes, including title page; author, title, subject, and topic references. Send 35 cents in stamps or coin, or include it with your subscription renewal check or money order. Indexes to earlier volumes are also available.

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April: THE SUN'S FAMILY.

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April: EASTER — THE AWAKENING, and FORECASTING THE WEATHER.

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April: STARS AND ATOMS.

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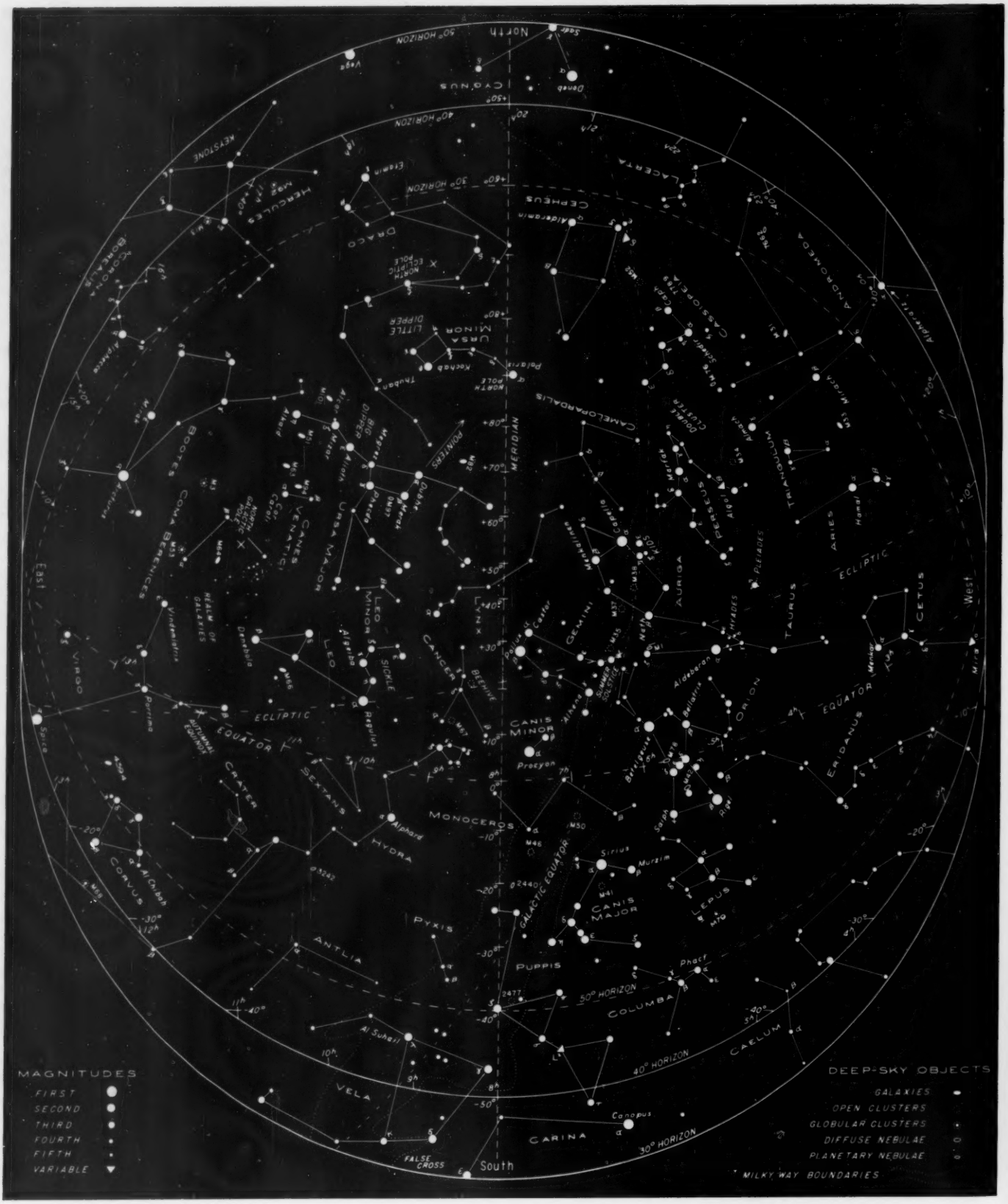
April: THE EASTER STAR PARADE.



DEEP-SKY WONDERS

THE REGION of northern Canis Major and southern Monoceros is little known to most amateurs, although between 6^h and 7^h, declination 0 to $-10°$, the NGC lists more than 30 objects. Charts of this area are poor and identification troublesome.

NGC 2323, M50, $6^h\ 58^m$, $-8°\ 12'$. A moderately dim cluster with an overlay of bright stars.

NGC 2261, $6^h\ 34^m$, $-8°\ 50'$. The famous variable nebula with R Monocerotis at its tip. Unlike most objects, this bears high powers well and is worth the search. AAVSO chart 063308 "d" is the best means of locating the field.

NGC 2287, M41, $6^h\ 42^m$, $-20°\ 38'$; a bright sprawling cluster lying under

(Continued on page 26)

CHART CORRECTION: Bellatrix, in Orion, should be labeled Gamma, instead of Beta.

STARS FOR MARCH

from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

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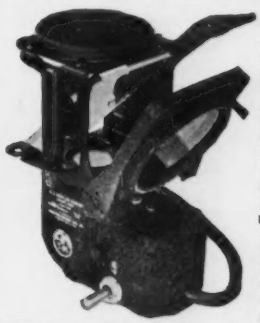

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HERE AND THERE WITH AMATEURS

This is not intended as a complete list of societies, but rather to serve as a guide for persons near these centers, and to provide information for transplanted amateurs who may wish to visit other groups. The asterisks denote societies whose members receive *Sky and Telescope* as a privilege of membership.

City	*Organization*	*Date*	*P.M.*	*Season*	*Meeting Place*	*Communicate with*
BADEN, PA.	*Beaver Co. A.A.A.	2nd Tue.	8:00	Sept.-June	Private homes	Mrs. R. T. LuCaric, Bx. 463, *Baden* 4801
BOSTON	*Bond Ast. Club	1st Thu.	8:15	Oct.-June	Harvard Obs.	Miriam Dickey, Harvard Observatory
"	*A.T.M.s of Boston	2nd Thu.	8:00	Sept.-June	Harvard Obs.	A. G. Hall, 206 Maplewood St., Watertown
BROOKLYN, N.Y.	Astr. Dept., B'klyn Inst.	Rd. Table 3rd Thu.	8:15	Oct.-April	Brooklyn Inst.	William Henry, 154 Nassau St., N. Y. C., *BA.* 7-9473
BUFFALO	*A.T.M.s & Observers	1st, 3rd Wed.	7:30	Oct.-June	Mus. of Science	J. P. Dow, E. Main St., R. D. 3, E. Aurora
CHATTANOOGA	Barnard A. S.	2nd Thu.	7:30	Oct.-May	Mfrs. Assn. Bldg.	C. T. Jones, 302 James Bldg., *CHat.* 7-1936
CHICAGO	*Burnham A. S.	2nd Tue.	8:00	Sept.-June	Chi. Acad. of Sciences	J. M. Showalter, 6200 Kenmore Ave.
"	Chicago A. S.	Monthly	8:00	.....	Adler Planetarium	Adler Plan., *Wabash* 1428
CINCINNATI	*Cin. A. A.	2nd Fri.	8:00	Sept.-June	Cincinnati Obs.	Dan McCarthy, 1622 DeSales Lane
"	*Cin. A. S.	2nd Wed.	.....	.....	5556 Race View Ave.	A. H. Hasemeier, 2945 Ravogli Ave.
CLEVELAND	Cleveland A. S.	Fri.	8:00	Sept.-June	Warner & Swasey Obs.	Virginia Burger, Warner & Swasey Obs.
COLUMBIA, S. C.	Northern Cross A.S.	Every Mon.	8:15	All year	Melton Observatory	Dr. L. V. Robinson, Univ. of S. C.
DAYTON	A.T.M.'s of Dayton	3rd Sat.	Eve.	.....	Private homes	W. C. Braun, New Lebanon
DAYTONA BEACH	D. B. Stargazers	Alt. Mon.	8:00	Nov.-June	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
DETROIT	*Detroit A. S.	2nd Sun.	3:00	Sept.-June	Wayne U., Rm. 187	E. R. Phelps, Wayne University
"	*N. W. Detroit A. S.	1st Tue.	8:00	Sept.-June	Redford High Sch.	John W. Broxholm, 21412 Pickford
DULUTH, MINN.	Darling Ast. Club	1st, 3rd Fri.	8:00	All year	Darling Observatory	Sam M. Cox, 127 N. 10 Ave. E., *Hem.* 4728
FT. WORTH	Tex. Observers	No regular meetings				Oscar E. Monnig, 1010 Morningside Dr.
GADSDEN, ALA.	Ala. A. A.	1st Thu.	7:30	All year	Ala. Power Audit.	Brent L. Harrell, 1176 *W* or 55
GENEVA, ILL.	*Fox Valley A. S.	3rd Tue.	8:00	.....	Geneva City Hall	Joseph Zoda, 501 S. 6th, St. Charles
HOUSTON	*Houston A. S.	Last Fri.	7:30	All year	Mus. Nat. Hist. Annex	W. D. Martin, 5624 Dwinnel Dr.
INDIANAPOLIS	Indiana A. A.	1st Sun.	2:15	All year	Odeon Hall	E. W. Johnson, 808 Peoples Bank Bldg.
JACKSONVILLE	*J. A. A. C.	1st, 3rd Mon.	8:00	All year	Private homes	E. L. Rowland, Jr., 442 St. James Bldg.
JOLIET, ILL.	Joliet A. S.	Alt. Tue.	8:00	Oct.-May	Jol. Mus. & Art Gall'y	Mrs. Robert L. Price, 403 Second Ave.
LOS ANGELES	L.A.A.S.	2nd Thu.	8:15	.....	2606 W. 8th St.	A. M. Newton, 2606 W. 8th St.
LOUISVILLE, KY.	L'ville A. S.	1st Tue.	8:00	Sept.-May†	University Center, Univ. of Louisville	B. F. Kubaugh, 621 S. 34th St.
MADISON, WIS.	Madison A. S.	2nd Wed.	8:00	All year	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
MEMPHIS	A.T.M.s of Mem.	Meetings suspended				R. E. Wendt, Jr., 2084 Linden Ave.
MIAMI, FLA.	Southern Cross A.S.	Every Fri.	7:30	All year	M. B. Lib. Grounds	A. P. Smith, Jr., 426 S.W. 26th Road
MILWAUKEE	Milw. A. S.	1st Thu.	6:15	Oct.-May††	City Club	E. A. Halbach, 2971 S. 52 St.
MOLINE, ILL.	*Pop. Ast. Club	Wed.†††	7:30	Feb.-Nov.	Sky Ridge Obs.	Carl H. Gamble, Route 1
NEW HAVEN	New Haven A.A.S.	4th Sat.	8:00	Sept.-June	Yale Obs.	J. J. Neale, 29 Fairmont Ave.
NEW ORLEANS	A.S. of N. Orleans	Last Wed.	8:00	Sept.-May	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
NEW YORK	*A.A.A.	1st, 3rd Wed.	8:15	Oct.-May	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *EN.* 2-8500
"	Junior Ast. Club	1st, 3rd Fri.	8:00	Oct.-May	Amer. Mus. Nat. Hist.	J. B Rothschild, Hayden Plan., *EN.* 2-8500
NORFOLK, VA.	*A.A.S. of Norfolk	2nd Thu.	8:00	All year	635 W. 29th St.	P. N. Anderson, 635 W. 29th St.
NORWALK, CAL.	Excelsior Tel. Club	Thu.	7:00	All year	Excelsior Union H. S.	Geo. F. Joyner, 410 Sproul St.
NORWALK, CONN.	Norwalk Ast. Soc.	Last Fri.	8:00	Sept.-June	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-5947
OAKLAND, CAL.	*Eastbay A. A.	1st Sat.	8:00	Sept.-June	Chabot Obs.	Miss H. E. Neall, 6557 Whitney St.
OWENSBORO, KY.	*Owensboro A. C.	3rd Sat.	8:00	All year	Public Library	Herman Batt, 1507 Hathaway St.
PHILADELPHIA	A. A. of F. I.	3rd Fri.	8:00	All year	The Franklin Inst.	Edwin F. Bailey, *Rit.* 3050
"	*Rittenhouse A. S.	2nd Fri.	8:00	Oct.-May	The Franklin Inst.	A. C. Schock, *Rit.* 3050
PITTSBURGH	*A.A.A. of P'burgh	2nd Fri.	8:00	Sept.-June	Buhl Planetarium	Louis E. Bier, 837 Estella St.
PONTIAC, MICH.	*Pontiac A.A.A.	2nd Thu.	8:00	All year	Private homes	Harvey E. Orser, 34 Pine St.
PORTLAND, ME.	A.S. of Maine	2nd Fri.	8:00	All year	Private homes	H. M. Harris, 27 Victory Ave., S. Portland
PORTLAND, ORE.	*Portland A.S.	1st Wed.	7:00	All year	Central Pub. Lib.	H. J. Carruthers, 427 S. E. 61 Ave.
"	A. T. M. & O.'s	2nd Tue.	8:00	All year	Private homes	N. C. Smale, 831 N. Watts St.
PROVIDENCE, R. I.	Skyscrapers, Inc.	Mon. or Wed.	8:00	All year	Ladd Observatory	Ladd Obs., Brown U., *GA.* 1633
RENO, NEV.	A.S. of Nev.	4th Wed.	8:00	All year	Univ. of Nevada	G. B. Blair, University of Nevada
ROCHESTER, N. Y.	Roch. Ast. Club	Alt. Fri.	8:00	Oct.-May	Univ. of Rochester	Edwin M. Root, 110 Hamilton St.
SACRAMENTO	Sac. Val. A. S.	.....	8:00	All year	Sacramento College	S. J. Smyth, 246 41st St.
SAN DIEGO, CAL.	Ast. Soc. of S. D.	1st Fri.	7:30	Oct.-June	504 Elec. Bldg.	R. M. Lippert, Box 41, N. Park Sta.
SCHENECTADY	S'tady Ast. Club	Meetings suspended				C. H. Chapman, 216 Glen Ave., Scotia
SOUTH BEND, IND.	St. Joseph Val. Ast.	Last Tue.	8:00	All year	928 Oak St.	F. K. Czyzewski, South Bend Tribune
TACOMA, WASH.	Tacoma A.A.	1st Mon.	8:00	All year	Coll. of Puget Sd.	Dorothy E. Nicholson, 2816 No. Union Ave.
TEANECK, N. J.	Bergen Co. A. S.	2nd Wed.	8:30	All year	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
TULSA, OKLA.	Tulsa A.S.	Occasional meetings				V. L. Jones, 4-8462
WASHINGTON, D.C.	Nat'l. Cap. Ast'mers	1st Sat.	8:00	Oct.-June	U. S. Nat'l. Museum	L. North, 805 Mt.Vernon Pl. N.W., *Na.* 3377
WICHITA, KANS.	*Wichita A.S.	1st Wed.	8:00	All year	To be announced	Dollie Ratcliff, 801 Maple, 2-1822
WORCESTER, MASS.	*Aldrich Ast. Club	2nd Tue.	7:30	All year	Mus. Natural History	Ruth Foley, 9 Oberlin St., 63101
YAKIMA, WASH.	Yak. Am. Ast'mers	1st Tue.	8:00	All year	Chamb. of Comm. Bldg.	Edward J. Newman, 324 W. Yakima Ave.

†June, Jul., Aug., informal meetings. ††Dinner meeting. †††Nearest 1st-quarter moon.

IN FOCUS

(Continued from page 2)

Pallas. This formation, near Murchison, seems to have more complete walls, and there is a central mountain. Goodacre calls attention to the curved ridges southward from Pallas, which give the appearance of being the remains of complete rings.

Timocharis. This crater, standing isolated on Mare Imbrium, is less than 25 miles in diameter, and has walls about 7,000 feet above its interior. Its central mountain has a craterlet in its summit.

Triesnecker. This crater is nearly 15 miles in diameter. To the west of it is a system of clefts (invisible at this illumination), some of which can be observed with small telescopes.

Ukert. This crater, about the size of Triesnecker, has what have been described as polygonal walls.

DEEP-SKY WONDERS

(Continued from page 24)

Sirius, visible to the naked eye according to Webb and Olcott.

NGC 2318, 14', $6^h\ 55^m$, $-13°\ 34'$; plotted in Norton but not included in catalogues of galactic clusters. This object is not found in a 6-inch RFT, nor in the Ross **Atlas.**

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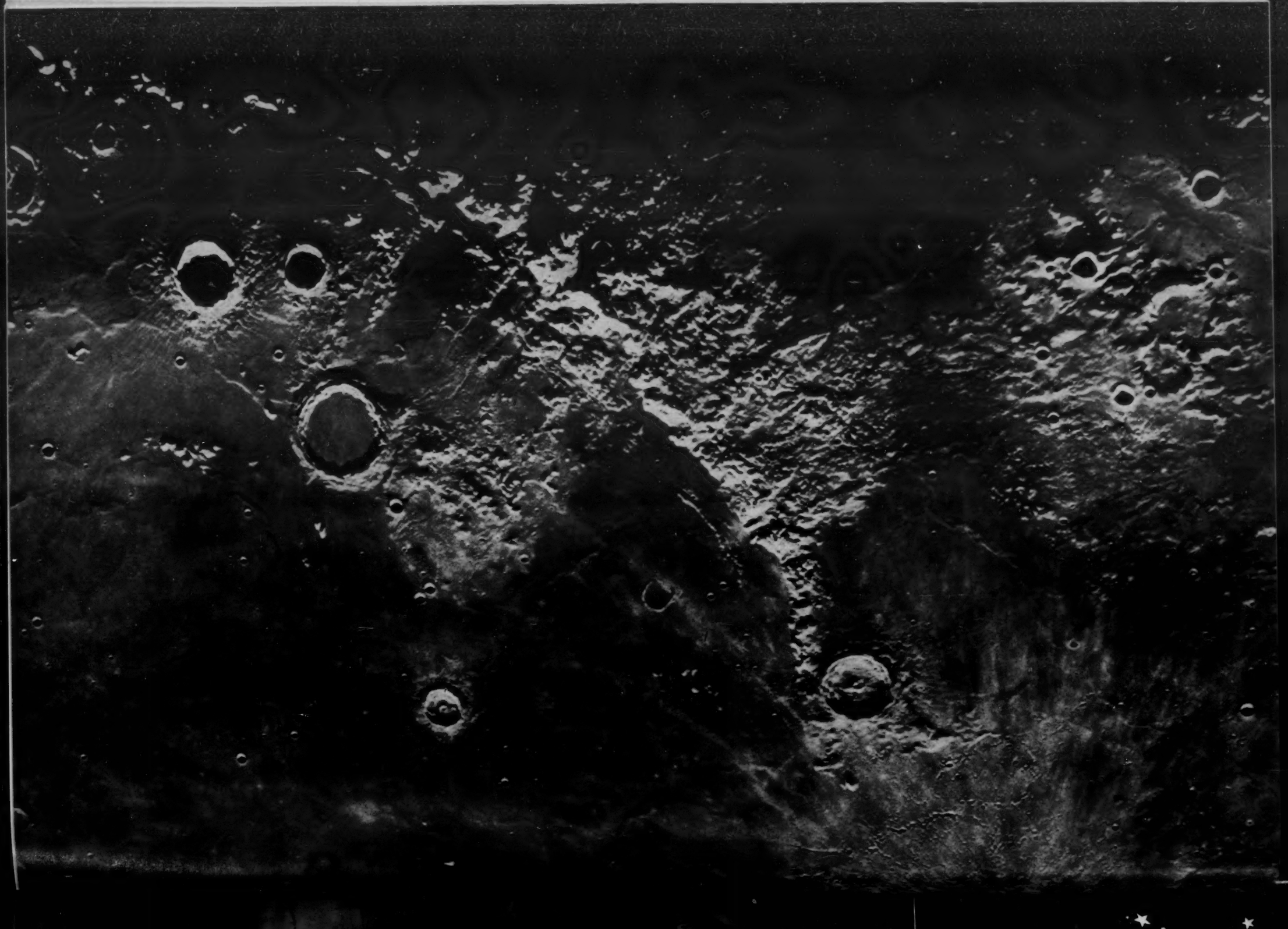
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